State of Kentucky's Environment

A Report of Progress and Problems

Prepared by the

Environmental Quality Commission
Commonwealth of Kentucky

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The Kentucky Environmental Quality Commission is an independent seven-member citizen board, established under state law, to advise the Governor and the Natural Resources and Environmental Protection Cabinet on environmental matters. The Commission serves as a working public forum for the exchange of views, concerns, information, and recommendations relating to the quality of Kentucky's environment.

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The Cumberland River
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Dear Readers:

It was 30 years ago when Harry Caudill's Night Comes to the Cumberlands raised the consciousness of Kentucky and the nation about the degradation and exploitation of our land and human resources.

Kentucky has come a long way since then. The progress outlined in the Environmental Quality Commission's "State of Kentucky's Environment: A Report of Progress and Problems" warrants optimism that the quality of our natural environment is improving.

During the past two decades, thousands of miles of streams have been restored, air pollution in our cities has been greatly reduced, and we have taken steps to clean up hundreds of waste dumps and reclaim old sites. Consider these examples:

— The percentage of monitored rivers and streams in Kentucky impaired by pollution has declined from 70% in 1970, to 36% today.
— The quality of public drinking water has improved for many Kentuckians. Violations of drinking water standards for bacteria have decreased 90% during the last decade.
— Statewide sulfur dioxide emissions from power plants have been reduced nearly 50% since 1980.
— 105 Kentucky counties now have ordinances for universal garbage collection, compared to 14 in early 1991.
— Less soil is eroded from state cropland preserving productivity and preventing water pollution. Kentucky now leads the nation in farmland conservation practices.
— Thousands of acres of abandoned mine lands have been reclaimed, minimizing their impact on small mountain streams.

We have accomplished these improvements while our population and economy have grown. This clearly indicates that environmental health and economic growth are not mutually exclusive and can coexist.

We cannot rest on these accomplishments as we still face major challenges to restore and preserve our resources. The "State of Kentucky's Environment" report reveals the many problems that confront the Commonwealth. Managing solid wastes, protecting our groundwater resources, preserving unique natural areas, reducing hazardous and toxic wastes, and controlling the release of air toxics are among the important issues that must be addressed.

Evidence of Kentucky's commitment to meeting these challenges is increasing every day. Individuals, industries, government agencies, and communities are joining forces to solve environmental problems while preventing new ones. This cooperative spirit is found in the leadership of the Natural Resources and Environmental Protection Cabinet, where Secretary Phillip Shepherd and Deputy Secretary Greg Higdon share a commitment to making the agency fair and responsive to the needs of all Kentuckians.

I will work toward achieving a clean and healthy environment. With the commitment of all Kentuckians, I am confident we will accomplish our vision and make Kentucky an even better place for our children and grandchildren to grow and prosper.

Sincerely,

Brereton C. Jones, Governor
Commonwealth of Kentucky

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Acknowledgments

What is the "State of Kentucky's Environment?" The Kentucky Legislature directed the Environmental Quality Commission in 1990 to consider this question and review and report conditions and trends in the health of the state's water, air, and land resources to determine environmental quality in the Commonwealth.

This first–time assessment required more than a year to complete and represents information assembled from government, academic, industry, and environmental organizations. The members of the Environmental Quality Commission directed the project. The principal authors were Leslie A. Cole, Executive Director of the Environmental Quality Commission, and Peggy Pauley, Assistant Director. Cecilia Hayden, Executive Assistant, and Paula Nye, Administrative Secretary to the Commission provided support in the development of this report. April Rooks DeLuca provided graphic design and layout services and was assisted by Holly Tincher. The report was edited by Lou Martin and printed by Gateway Press.

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The Commission would also like to express its appreciation to Governor Brereton C. Jones and the Kentucky Legislature for their support of this initiative. The Commission would particularly like to thank former State Representative Tom Jones of Lawrenceburg, who believed in the need for such an environmental assessment to better guide current and future policy decisions.

The Environmental Quality Commission also acknowledges and expresses its deepest appreciation to the Mary and Barry Bingham, Sr. Fund, the Natural Areas Program of Eastern Kentucky University, and Cumberland College whose financial support made the publication of this report possible.

The majority of the charts and graphs in this report were prepared by the Environmental Quality Commission using data provided by various state agencies. The Commission welcomes any comments, corrections, or additions in order to refine and update information for future publications.

Any opinions, findings, or conclusions in this publication are those of the Environmental Quality Commission and do not necessarily reflect the views or policies of the agencies or organizations mentioned above.◆

Executive Summary

During the past 18 months, the Environmental Quality Commission has been preparing the "State of Kentucky's Environment: A Report of Progress and Problems." The report was mandated by the legislature to assess environmental trends and conditions in the state.

This assessment provides the first complete picture of Kentucky's environment in which both progress and problems can be viewed. Seven major areas are reviewed in the report:

- Water Resources
- Air Quality
- Waste Management (hazardous, solid, special, medical, low–level radioactive)
- Toxics
- Natural Resources (land use, agriculture, forestry, natural areas, fish and wildlife, threatened and endangered species)
- Coal Mining
- Energy

In each chapter, the Environmental Quality Commission assessed trends, where available, to determine if the investments Kentucky has made in protecting the environment are achieving results. State environmental costs, regulatory compliance, and strategies are generally reviewed in the report's Overview which follows the Executive Summary.

Nearly 300 charts depicting environmental trends have been prepared along with accompanying narrative. The report is intended to provide state policy makers as well as the citizens of the Commonwealth with a better understanding of the environmental conditions in Kentucky and the many challenges facing the state in the 1990s and beyond.

The Commission hopes to publish periodic updates to this report to monitor the state's progress in achieving a clean and healthy environment. In addition, the Environmental Quality Commission will prepare "green papers" on some of the key issues outlined in this report. These papers will review policy and program options to address the environmental problems confronting Kentucky. A "teacher's guide" to the "State of Kentucky's Environment" report is also being prepared and will be available upon request in August 1992.

Chapter 1 Water Resources

Kentucky's water resources have been greatly altered over the years due to channelization, impoundments, and pollution. While state investments to improve water infrastructure and control industrial and municipal discharges have led to overall improvements in water quality, these gains can easily be reversed without a continued commitment to managing and protecting these vital resources.

Rivers and Streams Kentucky's 89,000 miles of rivers and streams are cleaner today than they were 20 years ago due to the better control of industrial and municipal wastewater discharges. However, more than one–third of the 10,659 stream miles monitored are still impacted by pollution and water quality varies considerably in different regions of the state.

Many streams are impacted to the extent that they can no longer be fully used for fishing, swimming, or drinking. The greatest threat to Kentucky waterways is pollution from mining, farming, logging, and urban runoff. Runoff pollution is the primary reason why more than half of the streams and rivers impaired by pollution cannot be used for their designated purpose. Nonpoint runoff remains a major pollution problem not fully addressed in Kentucky, as well as in the nation. Currently, the primary means of controlling these discharges is through voluntary measures.

Discharges from wastewater treatment plants continue to pollute 29% of the state's impaired waterways. Improvements have been made at many of the state's 258 municipal wastewater treatment plants and violations of water quality standards have steadily declined at most major facilities. The pretreatment of waste by 520 industries prior to its discharge to municipal treatment plants has also assisted in reducing pollution released into streams. However, 21% of the industries with pretreatment programs are currently in significant noncompliance with their requirements.

While infrastructure improvements have assisted in reducing violations of water quality standards at the state's 63 major municipal wastewater treatment plants (WWTPs), many of the 173 minor WWTPs continue to contribute bacteria and other pollutants to surface waters. In addition, many of the state’s 1,936 small package plants, which treat domestic sewage from residential communities, are polluting the small streams to which they typically discharge. Enforcing state water laws and regulations at package plants has been difficult due to their number. State and local actions to promote the consolidation of package plants have met with some success, however, additional efforts will be needed to address the cumulative impacts of these plants and prevent future problems.

Industrial wastewater discharges, responsible for 25% of the stream pollution in 1982, now represent only 3% of the problem. Currently, 12% of the state’s 928 industries which hold water discharge permits are not complying with their requirements.

While water discharges of some pollutants are now better controlled by municipal and industrial sources, the problem of toxic discharges to streams has only recently been recognized. Since 1987, manufacturing industries have discharged 3.2 million pounds of toxic substances into state waterways. Toxicity tests have revealed problems at over 63% of the stream locations sampled and led to the posting of the four fish consumption advisories currently in effect in Kentucky. Nearly 35% of the 112 industry and municipal facilities currently monitoring their discharges for toxicity have failed to meet requirements.

Oil and gas production also continues to pollute streams with salty brines removed during the drilling process. With nearly 30,000 oil and natural gas operations in Kentucky, the enforcement of water quality standards at these facilities has been difficult. Chloride levels from brine pollution were increasing at 11 of the 14 streams which were continuously monitored during 1988 through 1989. However, during 1991, some monitoring stations in the Kentucky and Licking rivers recorded decreasing chloride levels. This may indicate that enforcement of the state chloride standard, adopted in 1985, is achieving positive results.

Lakes and Reservoirs Kentucky has 159 public lakes and 19 major reservoirs which provide drinking water supplies and recreational opportunities. In addition, there are an estimated 75,000 private lakes larger than one–quarter of an acre in the state.

More than one–third of the state’s 102 public lakes assessed are impaired by pollution. Discharges from industrial and municipal facilities contribute 23% of the pollution problems in lakes. The state currently permits 107 discharges to lakes, primarily from small package treatment plants.

The accumulation of sediments and nutrients from agriculture, mining, and other land disturbing activities, is responsible for 54% of the pollution problems in lakes. Runoff pollution has resulted in a variety of problems including reduced lake depths, green scum on the water surface, and unhealthy fish populations. Nearly half of the 102 lakes assessed in Kentucky are prematurely aging due to pollution and siltation.

Groundwater The quality of Kentucky’s groundwater resources is essentially unknown even though it supplies 20% of the state's drinking water needs.

Kentucky still has no standards or classification system to protect high quality and critical groundwater resources. Instances of groundwater contamination are being detected more frequently across the state. Contamination is caused by many sources including thousands of leaking underground storage tanks, landfills, hazardous waste sites, unplugged oil and gas wells, septic tanks, and poorly constructed water wells.

Degradation of groundwater resources has occurred in several communities including the Mammoth Cave area and Marshall, Scott, and Warren counties. Groundwater contamination has also been detected at many of the hazardous waste sites and municipal solid waste landfills with groundwater monitoring; posing a threat to public and private water supplies in nearby communities.

Efforts to protect groundwater quality in Kentucky have been limited and cleanup of contaminated supplies has been difficult. State programs have primarily focused on ensuring the proper construction of water wells to minimize pollution problems and requiring certain facilities to monitor groundwater quality. There is a critical need for consistent collection and analyses of groundwater data in order to assess quality and identify problems.

Local efforts to protect groundwater resources and prevent pollution have been slow to develop. Only two communities in Kentucky are in the process of establishing programs to protect groundwater recharge areas.

Drinking Water Currently, about 3.5 million Kentuckians are served by public drinking water systems, an increase of 400,000 since 1985. The quality of public drinking water provided by these 859 systems has improved over the years. For example, violations of bacteria and turbidity drinking water standards in treated water decreased more than 90% during the last 10 years.

However, many small public drinking water systems are still experiencing problems. A majority of the chronic violations occur at small plants, primarily due to infrastructure deficiencies and poor operation and maintenance. State efforts to consolidate these systems and promote better water treatment have resulted in the merger of 334 plants since 1980. Kentucky will need an estimated $400 million over the next five years to improve drinking water systems.

Kentucky is just beginning to assess the extent of organic chemicals in its public drinking water supplies. Testing for eight regulated organic chemicals revealed that 60 systems had measurable levels of one or more of these chemicals in drinking water. Six systems exceeded standards and treatment or alternative water supplies were provided. About 12% of the 48 systems that rely on groundwater for public drinking water supplies detected organic chemicals, primarily related to solvents used for commercial and industrial activities. Additional monitoring requirements to take effect in 1993 will determine the extent of these and other chemicals, including several pesticides, in Kentucky's public drinking water.

It is estimated that half of the state's private water wells used for drinking are contaminated by bacteria, largely due to poor well construction. Pesticides were detected at low levels in 31% of the 200 private wells sampled in four rural counties. Nitrate contamination from fertilizers was also detected during the testing, and 6% of the wells exceeded standards. While many rural Kentuckians depend on water wells for drinking, most have not been tested for contaminants. The quality of private drinking water sources in Kentucky is largely unknown.

Water Availability Kentucky has abundant water resources, however, availability is variable with periodic episodes of drought as well as flooding.

Nearly 10% of the state's population are considered vulnerable to water supply shortages due to drought. Competitive uses of water in Kentucky also contribute to water shortages. Managing supplies is difficult due to the many exemptions to the state's water withdrawal permitting program. Water used for agriculture, power generation, and oil and gas production represents 80% of all water withdrawn in Kentucky. These uses are currently exempt from state water withdrawal permitting requirements.

Many local public water system managers do not have an accurate measurement of available water supplies and demands, or historical records with which a measurement can be compared. Counties are now required to develop water supply plans, and 52 received state grant funds in 1991 to better prepare for future water supply needs.

In contrast, flooding typically occurs every year in Kentucky. The state had significant floods in seven out of the last 17 years. Counties are better prepared for flood emergencies since all now have flood response plans. Measures to prevent flood damage by restricting development in the floodplain have been adopted in 257 Kentucky communities as well, but enforcement of these measures is considered weak. And 61 communities vulnerable to floods have yet to adopt floodplain development ordinances. The state is also attempting to control floodplain development through permits.

Kentucky has hundreds of dams, providing pools of water for public drinking supply, recreation, and other uses. Most dams do not meet current acceptable design criteria, and 37% are classified as high or moderate hazard dams with the potential to cause loss of life or property should they fail. During the last two years the state responded to 12 dam emergencies.

The 14 Kentucky River locks, which also provide pools of water for both navigation and drinking, have deteriorated so greatly that one was closed in 1991 due to safety reasons. The state is in the process of assuming ownership of the locks from the U.S. Army Corps of Engineers which currently provides funds to the state for their operation. However, the costs to repair and operate the locks are great and Kentucky has filed suit alleging that the Corps failed to adequately address and maintain the locks.

Chapter 2 Air Quality

Kentucky's air quality has generally improved during the last 20 years, primarily because of the control of conventional pollutants such as groundlevel ozone, particulates, and nitrogen dioxide. Maintaining these improvements by regulating emissions at the 3,000 air pollution sources in Kentucky is a significant challenge. Statewide, 6% of these sources are out of compliance. Nearly 28% of the 400 air pollution sources in Jefferson County are not meeting air quality standards or permit requirements. Adding greatly to this challenge are the mandates of the Clean Air Act Amendments of 1990 which tackle the more complex problems of air toxics, acid rain, and global warming.

Conventional Air Pollutants
Groundlevel ozone, or smog, is the only conventional pollutant for which state control strategies have failed to achieve standards statewide. Fifteen Kentucky counties are classified as non-attainment for the national ambient air quality standards for ozone. Additional controls in seven of the counties will be required, including vehicle exhaust testing in Northern Kentucky and Boyd County. However, since the other eight counties have met the standard during the past three years, the state will request the U.S. EPA to reclassify them as attainment to reflect their compliance with the ozone standard.

All regions of the state currently meet the nitrogen dioxide standard, as they have in the past. However, the average air concentrations of this pollutant are increasing in three of the seven regions monitored by the state.

The only area of Kentucky that has experienced a problem meeting the carbon monoxide air quality standard is Jefferson County. This county is now in compliance as a result of a vehicle emissions testing program. Five of the state's six monitored regions experienced declines in ambient carbon monoxide levels between 1975 and 1990, primarily due to better emission controls on automobiles.

The new standard for airborne particulates has been achieved in all monitored regions of the state, although several areas failed to meet the previous standard. Particulates, which can be imbedded in the lungs and cause health problems, fluctuate as a result of weather conditions and specific emission sources. Most regions have witnessed a general decline in airborne particulates during the past 15 years.

Lead, another conventional air pollutant, has been significantly reduced in the air since leaded gas was phased out during the 1970s and 1980s. The Jefferson County area has historically had the highest lead levels in the state. Lead emissions there have declined 99%, although elevated lead levels in the soil remain in many areas of Louisville. All counties are currently meeting the air quality standard for lead.

Sulfur dioxide standards are also being achieved throughout Kentucky, with the exception of Boyd County near Catlettsburg. This is a marked improvement since the late 1970s when seven areas failed to meet the standards. A 48% reduction in sulfur dioxide emissions from coal–fired power plants, which contribute about 90% of these emissions, is largely responsible for the decline. However, some regions of the state had higher sulfur dioxide air concentrations in 1990 than those recorded in earlier years.

Air Toxics The threat of air toxics has become increasingly recognized and efforts to control these emissions are evolving.

More than half of the 79 million pounds of toxics reported by businesses in Kentucky during 1990 were released into the air. Highly industrialized counties such as Jefferson, Marshall, and Hancock received a large portion of the air toxics released in the state. Nearly 60% of the toxic chemicals released into the air during 1990 were considered highly toxic or were known or suspected carcinogens. Most were emitted by three industrial facilities in Kentucky.

The state began to regulate air toxics in 1986, but many charge that current efforts do not adequately ensure public protection. Federal air toxics rules are expected in the next few years and will be incorporated into the state program as they take effect. Efforts to encourage industries to reduce toxic air emissions have met with some success, although much more is needed to minimize the health and environmental threats of these chemicals.

Acid Rain Some air pollution problems result from the transport of pollutants to areas far "downwind" of emission sources. This is especially true for the problem of acidic deposition, commonly known as acid rain.

The formation of acid rain is linked to sulfur dioxide and nitrogen oxide emissions from burning fossil fuels. Emissions from coal burning power plants in the Ohio River Valley are suspected of contributing much of the acid rain problems in the Northeastern U.S. and Canada. Although rainfall in Kentucky is becoming more acidic, it has not noticeably impacted the state's water or forest resources due to the naturally alkaline soils found here. Acid rain can also cause respiratory problems in exposed persons.

The federal Clean Air Act Amendments of 1990 require significant reductions in sulfur dioxide emissions during the next five years, and further reductions by the year 2000. Seventeen of the state's 58 coal–fired power plant units have installed scrubbers to control these emissions. Another ten units in the state will be required to reduce emissions by 1995 and an even greater number will be affected before the year 2000.

Global Warming and Ozone Depletion Global warming is the most complex air quality problem facing the world today. The slow, but steady rise in the earth's average temperature is attributed to increasing levels of greenhouse gases, especially carbon dioxide, as well as the depletion of the ozone layer. Many experts predict that rising temperatures will have widespread impacts on climate, ocean levels, food production, and water supplies during the next several decades and beyond.

Kentucky does not collect emissions data for carbon dioxide, although it may be required by the federal government in the near future. This information is needed to determine the present and future impact of carbon dioxide in the atmosphere. Atmospheric carbon dioxide concentrations worldwide have increased 25% over the last 100 years, with the greatest rate of increase occurring since 1960.

The depletion of the ozone layer is considered far worse than previously believed. This stratospheric layer shields the earth from ultraviolet light. The depletion of the ozone layer is linked to the increase in skin cancer and related deaths. Emissions of chlorofluorocarbons (CFCs), halons, and other chemicals are largely responsible for ozone depletion. (CFCs are used as propellants and refrigerants in air conditioners, freezers, refrigerators, and industrial refrigeration units.) Certain Kentucky industries are required to report these and other emissions. CFC emissions declined 51% between 1988 and 1990 in Kentucky as a result of a national phase–out of these chemicals.

Indoor Air Quality National attention is being focused on problems associated with indoor air pollutants such as radon gas, tobacco smoke, and asbestos.

Radon gas is a particular problem in Kentucky due to the state's geological characteristics and naturally occurring radium and uranium. Seventeen percent of the homes and buildings tested in a statewide survey had radon levels exceeding the health advisory limits. The level of radon gas occurring in homes and buildings is highly variable in Kentucky with the Central Region having the greatest concentrations. Schools are currently being surveyed for radon and state efforts to educate the public about radon and its health risks are ongoing.

The health risks of environmental tobacco smoke have risen to a national debate. In Kentucky some businesses and federally–funded hospitals have banned smoking. Additional federal requirements to eliminate tobacco smoke from the workplace may be issued by the National Occupational Health and Safety Administration (OSHA).

The problem of airborne asbestos, especially in schools, has been more fully assessed during the past three years. Asbestos was widely used in building insulation. Inhalation of asbestos fibers can cause lung cancer. Nearly 223 projects to remove this material from schools have been conducted in the state since 1988. It is estimated that over half of the 5,500 state–owned office buildings also contain asbestos. But costs associated with the removal of asbestos have limited abatement projects. The state has filed a multi–million dollar lawsuit against the manufacturers of asbestos to recover costs associated with its removal from state buildings.

Chapter 3 Waste Management

Kentucky generates a large amount of wastes each year. While the management and disposal of these wastes have improved, their impact to the environment is still substantial.

Hazardous Wastes Kentucky's hazardous waste regulations and programs have expanded since the state first enacted legislation in 1979. Hazardous waste generators as well as facilities that treat, store, and dispose these wastes are now permitted by the state, and are required to conduct monitoring and record keeping, and clean up contamination when problems are found.

The amount of hazardous waste generated in Kentucky has declined 36% between 1981 and 1990. In 1990, 6.3 million tons of hazardous waste were generated in Kentucky, a slight increase from 1989 when 5.8 million tons were produced by 338 major generators. Most of this waste was produced by ten facilities located in five counties. Smaller sources also generate hazardous waste in Kentucky, however, data is not available to determine the amount.

Almost 98% of the hazardous waste generated are corrosive wastewaters, a majority of which are treated on–site. These wastes generally pose little risk when properly treated and disposed. During recent years there has been a shift away from the physical treatment of these wastes to chemical neutralization, due largely to the required closure of 24 hazardous waste surface impoundments in 1989.

The remaining 2% of the hazardous waste generated in Kentucky pose greater risks and require more sophisticated treatment and disposal. The amount of this type of waste generated increased 79%

between 1985 and 1989. Generally, these wastes are landfilled, incinerated, or burned as fuel. During 1989, nearly 92,000 tons of hazardous waste were incinerated at the state's five hazardous waste incinerators, an increase since 1988 when 26,000 tons were treated in this manner. The amount of hazardous waste disposed in two permitted industrial on–site landfills in Kentucky has declined 99.9% since 1986. Many facilities have moved away from landfilling hazardous waste to incineration due to the long–term liability associated with land disposal.

Another method for disposing hazardous waste is to blend the wastes for use as fuel. Since full reporting for this waste disposal method is not required, the amount of hazardous waste burned as fuel in Kentucky cannot be determined, although it may be significant.

Because blended wastes were not factored into the state's 1989 "Capacity Assurance" plan, some have challenged the accuracy of the assessment. (All states were required to prepare plans to determine the extent of hazardous waste disposal activities and ensure adequate capacity for the next 20 years.) In the plan, Kentucky determined that it exported more hazardous waste than it imported. Hazardous waste exported by Kentucky to other states for disposal represents about 2% of the total generated in the state. Trends show, however, that the amount of hazardous waste exported by Kentucky industries for disposal is declining, while the amount imported from other states is increasing.

State hazardous waste enforcement efforts have primarily focused on illegal facilities. Twenty-six are currently under enforcement action because they failed to notify the state of their activities as required by law. The state recently began assessing contamination problems at the 91 facilities that treat, store, or dispose hazardous waste in Kentucky. A review of 44 of these facilities revealed that 75% had potential contamination problems.

Abandoned or old waste sites are also contaminating Kentucky's environment. The status of the 518 known hazardous waste sites is difficult to determine since the state does not monitor these activities in a comprehensive manner. Cleanup of the state's 17 federal Superfund sites, which are listed as some of the worst sites in the nation, has progressed slowly. The costs to clean up Superfund and other Kentucky waste sites are estimated in the millions of dollars. The state established a fund to address these sites, financed through fees assessed on hazardous waste generated. The fees will raise far less than the $5 million originally expected to be collected annually. Due to exemptions, the fee will only raise $2 million a year, which will be primarily used to remediate the state's 17 Superfund sites.

To prevent future waste sites and minimize disposal and treatment costs, some industries are making an effort to reduce the generation of hazardous wastes by recycling and changing materials or processes. However, some of the state's major hazardous waste generators have cited incineration or off–site transfers as their primary "waste reduction" methods. Some question whether these measures actually reduce waste. A major factor affecting waste reduction efforts by large generators is the cost to re–equip facilities. Additional incentives and measures are needed to encourage waste reduction and pollution prevention for both large and small sources.

Municipal Solid Wastes Solid waste became a top priority in Kentucky after the state was targeted by waste brokers as a cheap disposal alternative for garbage from the Northeastern U.S. This development, combined with the fact that many municipal solid waste landfills were suspected of leaking contaminants into the groundwater, renewed state efforts to improve solid waste management and disposal. More stringent state regulations, adopted in 1990, established a schedule to close or upgrade landfills and require new ones to be properly sited, constructed, operated, and closed to minimize their impact on the environment.

Half of the state's 76 substandard municipal waste landfills are slated to close in 1992. However, it is estimated that the state will have enough space at the landfills remaining open to adequately dispose the 4.5 million tons of municipal solid waste generated annually until 1995. Meanwhile, 12 new landfills have applied for permits and another 23 existing facilities are expected to upgrade to meet the new standards. If approved, these landfills will provide the state with enough solid waste capacity for the next 40 years.

More than half of the solid waste disposed in municipal landfills is household garbage. Eighteen landfills are also permitted to receive certain wastes with toxic constituents including petroleum and PCB contaminated soils, as well as asbestos waste. One landfill is permitted to receive hazardous waste produced by limited quantity generators—those businesses that produce less than 220 pounds of hazardous waste a month. These landfills are required to monitor groundwater because of the potential threats some of these materials pose. Currently, 32 of the state's 76 municipal landfills monitor groundwater and 26 (81%) have detected contamination. All municipal solid waste landfills will be required to monitor groundwater by July 1992.

The state continues to respond to a record number of citizen complaints concerning landfill operations, although fewer inspections were conducted in 1990, compared to 1985. In 1991, however, inspections nearly tripled in number. These investigations have resulted in an increase in the number of violations cited and penalties collected. However, staff turnover continues to affect the solid waste enforcement program. In 1991, 80% of the inspectors had less than one year's experience.

To better plan for the management and disposal of wastes, the state required counties to update their 20–year solid waste management plans. All counties have submitted the first phase of their plans outlining capacity needs, and 119 have been approved by the state. Two multi–county regions have formed in Kentucky to develop regional disposal facilities. The other counties have chosen to develop single–county plans, but many have made provisions for sharing landfills.

The disposal of long haul out–of–state garbage in Kentucky fueled the state's 1991 solid waste laws. In 1990, about 20% of the garbage disposed in Kentucky was from outside the state. This amount, however, is declining with the closure of some landfills and efforts by others to reduce the amount of out–of–state garbage they receive. Each county now has an opportunity to determine how much out-of-area waste will be disposed in their municipal landfills. Through the solid waste plans, counties will assess capacity needs and determine whether additional landfill capacity will be provided for out-of-area wastes.

Because 10–20% of the state's garbage is illegally dumped, Kentucky's 1991 solid waste law requires counties to provide garbage collection to all residents by 1997. Currently, 105 counties have enacted ordinances for garbage collection, an increase of 91 since February 1991. It is hoped that these collection programs will assist in preventing open dumps. An estimated 5,000 open dumps are polluting surface and groundwaters. The costs to clean up these sites are great. Counties are now required to develop an open dump cleanup schedule as part of their solid waste plans.

Ensuring proper disposal of the more than 4 million used tires generated annually also poses an increasing challenge to the state. The $1 tire fee established in 1991 to fund the cleanup of waste tire piles in Kentucky has generated far less money than is needed to address these sites due to exemptions in the law.

Efforts to divert certain wastes from municipal solid waste landfills have been initiated. A state ban on the disposal of lead acid batteries in landfills took effect in 1991. Programs to collect used oil and household and agricultural chemicals in several counties have met with some success. However, one–day collection projects are expensive and not always convenient to the public. Alternatives, including permanent collection centers, are under consideration in some communities.

Recycling programs are increasing in Kentucky. Several communities have instituted curbside collection for recyclables and others have established convenience centers to collect these materials. Approximately 20% of the 155 newspapers in Kentucky use recycled paper. There are seven facilities in Kentucky which compost yard waste. Additional compost facilities are expected since yard waste makes up 30% of the waste stream disposed in municipal landfills. Continuing and expanding these efforts and developing additional markets for recyclable products will be critical if the state is to meet its goal to reduce solid waste 25% by 1997.

Industrial Solid Wastes Industries are also producing increasing amounts of solid wastes needing disposal. The amount disposed cannot be determined since reporting is not required. The number of permitted landfills which receive construction/demolition (inert) wastes and industrial waste by–products (residual) increased from 23 in 1974, to 43 in 1991.

Currently, 34 of the permitted inert and residual landfills have groundwater monitoring plans. It is not known how many of these facilities are actually testing groundwater. In the first quarter of 1991 the state only received monitoring reports from four industrial solid waste landfills, two of which detected groundwater contamination.

Industrial solid waste landfills will be repermitted or closed by June 1992 under the state's 1990 solid waste regulations. All will be required to monitor groundwater by July 1992.

Special Wastes Special wastes are those wastes of high volume but relatively low hazard and generally include waste from mining, wastewater treatment plant sludges, brines, and utility ash. These wastes have been regulated in the past as solid wastes and are generally disposed in landfills, injection wells, ponds, or are landfarmed.

State regulations are now being developed to manage special wastes separately from municipal solid wastes. These requirements will be somewhat less stringent than the municipal solid waste rules, although some wastes, such as sewage sludge, will continue to be regulated as they have in the past. Most sludge is disposed in landfills, however, higher disposal costs have led to an increase in the amount of sewage sludge that is landfarmed. Currently, the state permits 52 operations which landfarm sludge that has elevated levels of metals.

Fly ash and scrubber sludge, produced by power plants, will also be regulated under the proposed special waste regulations. The state presently permits 13 residual or inert landfills which dispose fly ash. These landfills will be repermitted as special waste landfills. Most ash, however, is disposed in an estimated 50 ponds. The extent to which these ponds are impacting groundwater is unknown since monitoring is not required.

Medical and Infectious Wastes
Medical wastes produced at hospitals and other health care facilities include solid wastes which are disposed at landfills and infectious wastes that require special treatment. While hospitals comprise only 4% of the medical waste generators, they produce about 90% of the infectious waste in need of disposal.

An estimated 6.8 million pounds of infectious waste is generated each year in Kentucky by hospitals. Most of this waste is burned in hospital incinerators. These units range in size, but most are small, with the exception of a commercial medical waste incinerator in Louisville.

New state rules designed to better control air emissions from medical waste incinerators will take effect in 1994. Some small incinerators may close due to the costs of meeting the standards, resulting in fewer but possibly larger regional medical waste incinerators in Kentucky.

Low–Level Radioactive Wastes
Low–level radioactive wastes are produced, handled, or disposed by 379 hospitals, universities, laboratories, and other facilities permitted in the state. In 1990, 4,616 cubic feet of low-level radioactive waste were transported out-of-state for disposal. This was a significant increase since 1987, when 176 cubic feet were reported disposed.

Kentucky's largest generator of low–level waste, the U.S. Department of Energy's Gaseous Diffusion Plant in Paducah, is not included in these statistics. This facility, which currently stores thousands of cubic feet of low–level and PCB/radioactive wastes on–site, is regulated by the federal government and exempt from state laws. Contamination from this facility has been detected in water wells north of the site. A study is underway to determine the extent of contamination both on and off–site. The state is also seeking a greater oversight role at the plant to monitor conditions and ensure compliance.

Radioactive contamination has also been detected at the Maxey Flats disposal site in Fleming County. This commercial low–level waste site operated from 1963 to 1977 and is now one of the state's 17 federal Superfund sites. The U.S. EPA has proposed to build a soil cap at the site and allow it to settle for the next 35 to 100 years before constructing a permanent cap. The cost to contain the site is estimated at $33.5 million. The site will be monitored in perpetuity through a trust fund set up by parties which disposed or were otherwise responsible for the waste.

Radioactive contamination has recently been detected in oil sludge pits in Eastern Kentucky in the Martha Oil fields. The number of these pits in the state and their environmental and public health impacts are not well known and are under investigation by state and federal officials.

Chapter 4 Toxics

Millions of pounds of toxic chemicals are released each year into Kentucky's air, water, and land. The extent and potential risks of toxic emissions to the environment and public health have just begun to be assessed in Kentucky and throughout the nation.

Toxic Releases In 1990, 79 million pounds of toxics were reported released or transferred off–site by Kentucky manufacturing industries, 80% of which were emitted in 13 counties. The amount of toxic emissions reported to the state has declined since 1987, the first year reporting was required. The decline, however, is attributed to more accurate reporting as well as a trend toward using non–reportable chemicals and, to some degree, reductions achieved through industrial process changes.

Nearly 32% of the reported emissions in the state were among the 17 highly toxic or known and suspected cancer causing chemicals prioritized for reductions by the U.S. EPA because of their risk. About 60% of the state's highly toxic emissions were released into the air during 1990, compared to 40% in 1988.

In January 1991, the federal government launched a program to encourage industries to voluntarily reduce these 17 highly toxic chemicals. Thirty–four corporate offices with plants in Kentucky have since committed to toxic emission reductions. Nine of these are among the state's top 25 emitters. However, these facilities represent only 10% of those reporting toxic emissions in the state.

Little is known about the impacts of toxic releases on the environment and human health. In an effort to better understand the interaction of these chemicals, a state/federal multi–media toxics study is underway in Calvert City. This area receives the second greatest amount of toxic releases in the state. Preliminary findings show elevated levels for some air toxics. A health study is also under consideration to identify any adverse health patterns in the area. Once complete, this project should assist in identifying problems and more effectively address the impacts of toxics in the environment.

Risk Assessment Risk assessment and risk management are relatively new approaches used to design cleanup strategies for toxic substances and hazardous wastes by assessing the risks posed to human health. The use of risk assessments in Kentucky is evolving, although some have criticized it as a means to reduce cleanup standards by allowing some level of waste, determined to be "acceptable," to remain.

Risk assessments have been used to design cleanup strategies at several of Kentucky's federal Superfund sites. In addition, risk assessments have been performed at the 24 natural gas transmission pumping stations where toxic PCB contamination was discovered. The use of risk assessments in designing cleanup strategies for leaking underground petroleum tanks and other contaminated sites will likely increase as responsible parties seek to reduce cleanup costs.

Toxics in the Home The average person can be exposed to many toxic substances in the home. One well–known substance is lead–based paint. Children are especially at risk for lead poisoning caused by ingesting flaking paint. Estimates indicate one of six children may have elevated lead levels in their blood. Some Kentucky communities have established programs to test and prevent lead poisoning in children. The federal government is expected to recommend that all children be tested for lead by the age of two.

Chapter 5 Natural Resources

Kentucky has a wealth of natural resources within its 25.8 million acres. These include forests, farmlands, and fish and wildlife resources. The treatment of these resources has shifted over the years, from exploitation to improved management and conservation policies. But growing state, national, and global demands will continue to place pressure on the state's land and natural resources.

Land Use and Management Extensive changes in land use and the environment occurred during the last century as the state was settled and experienced increasing population, urbanization, resource extraction, water and flood control projects, and other development activities. In 1990, more Kentuckians lived in urban settings than rural. Many communities are now experiencing impacts from residential and economic growth as a result of this trend.

Some communities are making an effort to manage growth and preserve the quality of their resources. Fifty–three counties have established planning commissions to manage growth in a balanced manner. However, public resistance to planning and zoning, especially in rural counties, has limited local efforts to address environmental issues associated with growth.

Incompatible use of land has been an increasing public concern, particularly when it involves the siting of landfills, waste incinerators, roads, and other development projects. During the past several years, the number of lawsuits challenging the environmental and natural resource impacts of a variety of development projects has increased. Efforts to promote the use of negotiation and mediation as alternative methods of resolving environmental disputes are evolving in Kentucky. In addition, public/private sector partnerships created to cooperatively plan and manage growth are beginning to form in some regions of the state.

Agriculture The U.S. Soil Conservation Service estimates that more than half of the state's land area is farmland. Kentucky continues to be among the leaders nationwide for the number of farms. However, state farmland acreage continues to decrease. The number of family–owned farms is also declining, primarily as a result of the shift to larger production agriculture in the state.

Kentucky leads the nation in the production of burley tobacco, and is ranked among the top 20 states for several other farm commodities, including hay and beef cattle. The production of crops has been tremendously intensified since the 1950s, due to the use of new technologies and products, particularly pesticides, fertilizers, and seeds. These factors have resulted in greater yields and increased commodity values despite the decrease of cropland acreage in production. While pastureland and livestock populations also continue to decrease, revenues realized from these commodities are at record levels in the state.

Kentucky is still losing its best farmland to other uses. Since 1982, more than a half million acres of prime crop and pastureland have been lost. State efforts to conserve farmlands have met with some success. For example, 159 Agricultural Districts offer protection to 167,417 acres of state farmland.

One of the greatest threats to farmland productivity is soil erosion. Sediment from eroding farmland is impacting the state's lakes and streams. Thirty percent of the state's monitored streams and rivers are impacted by agricultural runoff pollution. While soil erosion rates on Kentucky's farmland have improved over the years, they are still much higher than the national average. Efforts to reduce soil erosion by retiring 406,000 acres of the state's 1.4 million acres of highly erodible farmland have helped conserve farmland quality. Kentucky leads the nation in the use of conservation tillage with 2.1 million acres using these farming methods to minimize soil disturbance and reduce erosion.

In addition to soil erosion, runoff from livestock operations is contributing bacterial pollution to streams, rivers, lakes, and wetlands across the state. The state has issued 406 permits in an effort to control animal wastewater discharges from farm operations.

The effects of agricultural chemicals on the environment have not been fully assessed in Kentucky. In 1990, nine million pounds of agricultural pesticides (active ingredients) were sold in the state. Testing of public water systems detected very few instances of regulated pesticides in treated drinking water. But random testing of private water wells in four Western Kentucky counties revealed that 30% had detectable levels of triazines, although levels in most wells were below the standard.

Most pesticides used today do not persist long in water, but do accumulate in the food chain. Problems with accumulation of pesticides and other chemicals in fish tissue and sediment have led to the posting of four fish consumption advisories in Kentucky, but none have been associated with agricultural chemicals. Few instances of high levels of pesticides have been detected in the state during random sampling of raw agricultural commodities such as fruit and vegetables.

About 85% of Kentucky's farms use commercial fertilizers, although sales of fertilizers have declined 21% during the past decade. Runoff containing nitrogen fertilizers has impacted water quality and fish populations, particularly in lakes, by contributing excessive nutrients. Nitrate contamination in treated public drinking water is rarely detected in the state. Most of the private wells tested for nitrate in Kentucky detected this chemical, and 6% exceeded standards.

Pesticides and fertilizers can also contaminate the environment when unused chemicals and containers are improperly discarded. The agricultural community recently participated in a two–county voluntary effort in which 5,300 gallons of old pesticides were collected and properly disposed. Additional efforts to ensure the proper disposal of old agricultural chemicals are needed in Kentucky, especially in view of the state's dependence on its groundwater resources for drinking water supplies.

There are some ongoing efforts in Kentucky to reduce the amount of agricultural chemicals used by relying on careful attention to their timing and application. There is also increasing interest in the production of organically grown farm products across the state. Currently, 31 organic farms are certified by the state.

Forestry Kentucky's forests are both a valuable natural and economic resource. Forests cover 12.7 million acres of land in the state, an increase of 1.2 million acres since 1949. Forest diversity has changed over time in regard to species, quality, and size. For example, during the last ten years, the oak/gum/cypress forest group declined 19% due to the loss of forested wetlands in the state. Oak and hickory continue to remain Kentucky's dominant tree species.

A majority of the state's forests are owned by individuals, with the average size woodlot being 24 acres. This has made the management of these timberlands difficult. Forest industry ownership declined 20% between 1975 and 1988, primarily due to the divesting of wood yards by out–of–state pulpmills to minimize transportation costs.

Kentucky currently ranks fourth in the nation for hardwood production. Lumber production has been near record levels in recent years. While timber stands in the state are better stocked now than they have been during the last 50 years, some of the more desirable species are currently being harvested at an almost even growth/removal rate. Most, however, are harvested at a 2 to 1 growth/removal rate, indicating that Kentucky's forests are being cut at sustainable levels. The overall quality of timber, however, has declined somewhat, primarily due to poor harvesting practices. Timber production from Kentucky's only National Forest, the Daniel Boone, has increased slightly over the past 30 years, but may decrease in the future due to a shift away from clearcutting as a harvesting practice.

Recreational uses of public and private forestlands continue to increase. Record numbers of visitors have been recorded at many of Kentucky's publicly-owned forests. The use of private lands for recreation will likely increase as pressures continue to mount on the state's limited public land base.

One of the greatest threats to the forests of Kentucky is fire. Fires continue to impact forests, mostly in the heavily wooded eastern region of the state. On average, about one–third of Kentucky forest fires have been accidently caused from burning fields or trash and another 28% were purposely set. In recent years, however, the number of fires caused by arson has nearly doubled. Some success in prosecuting arsonists in the Central and Western regions of the state has been achieved, but more is needed to reduce forest fires. Disease, insects, and environmental factors are also impacting Kentucky's forests. Ozone pollution is considered an increasing threat to forests in the state, more so than acid rain, according to some experts.

Interest in tree planting, both in urban and rural settings, continues to increase in Kentucky. Most tree planting efforts are occurring on mine sites, with 58% of the trees purchased at state-owned nurseries used for this purpose. Twenty-five Kentucky communities have recently established local commissions to promote tree planting.

Natural Areas One of Kentucky's most outstanding qualities is the diversity and beauty of its natural landscape and biological communities. But natural areas, and the species that depend on them, have been greatly altered over the years.

Nearly all the state's original old growth forests and prairie lands have been lost and Kentucky's outstanding cave systems have been degraded by sewage, garbage, and vandalism. The net result has been diminishing habitat for many native and sensitive species, and the loss of recreational, historical, and cultural values. Less than one percent of the state's 25.8 million acres are protected as natural areas. Most of the 32,000 acres protected are federal or private lands.

While many important areas have been lost, there is still much in need of protection. This is particularly the case for wetlands. Almost 80% of Kentucky's original wetlands have been drained or filled. Many of the remaining 360,000 acres are degraded by pollution or threatened by development. Kentucky is in the process of mapping wetlands in the state. However, the national debate and subsequent policies regarding the definition of wetlands could affect the protection of 70% of the state's remaining wetlands.

State efforts to protect some of Kentucky's most outstanding and pristine natural streams have progressed slowly. Only nine stream segments have been designated as state Wild Rivers, most of which are located in the Cumberland River Basin. The designation of the Upper Red River as a National Wild and Scenic River has been pending federal action since 1984.

Another 57 stream segments are also protected by the state as Outstanding Resource Waters. Many of these streams are experiencing water quality problems, primarily as a result of runoff pollution from land disturbing activities. A recent river assessment revealed that many high quality waters in Kentucky continue to be degraded.

Fish and Wildlife Kentucky's fish and wildlife resources contribute to the state's economy, recreation, and unique character. While fish and wildlife populations fluctuate as a result of natural and human factors, the most significant problems facing these resources today are alteration and destruction of habitat.

Kentucky is ranked third nationally for the number of native fish and mussel species found within its borders. However, many are threatened or impacted by environmental pollution. Nearly half of the anglers surveyed in Kentucky believe that the quality of fishing has declined in recent years. To supplement fish populations, the state stocks streams with sport fish in 85 counties. Habitat protection, better watershed management, and vegetative buffer zones are needed in many streams to improve Kentucky's fishery resources.

Many of the state's mussel species are highly endangered or threatened with extinction. Commercial overharvesting and habitat degradation are the greatest threats to these species.

Many species of birds are declining in Kentucky as well. A survey of 129 nesting bird species in the state revealed that 40% have declined in population during the past 20 years. State efforts to restore wild turkeys in Kentucky, whose populations were near extinction in 1946, have been successful. The statewide wild turkey population is now estimated at 25,000.

Restocking efforts for deer have also led to dramatic increases. Deer populations, once reduced to 2,000 in Kentucky, have rebounded to more than 500,000. Other animals experiencing increases in population, although not as dramatic, are coyote and black bear. The state recently reopened a limited hunting season for bobcat after it was determined that populations were stable. Furbearer species which include raccoon, rabbit, squirrel, opossum, fox, and others are generally increasing in Kentucky due to a decrease in the demand for furs.

More than 90% of the vertebrate animals found in Kentucky are considered "nongame." Because these species are not regularly surveyed, it is difficult to assess population trends. These resources have generally received less attention than game species. State agencies have begun to report increasing activities to protect and manage nongame species, which some experts believe are declining statewide.

Threatened and Endangered Species Animal and plant populations not only provide many benefits to people, their presence, or lack of it, serves as an indicator of environmental health. Extinction rates worldwide are increasing due to pollution and development, resulting in an alarming decline in ecological diversity. In the U.S., about 9,000 plant and animal species are currently considered at risk of extinction.

In Kentucky, 330 native plant and 224 animal species are considered rare. Only 25 of these species are listed by the federal government as threatened and endangered species and afforded protection. Ninety-five species occurring in Kentucky are currently under federal review for listing. It often takes the federal government years to list a species and several have become extinct while awaiting consideration.

About two–thirds of the 25 federally–protected species occurring in Kentucky are dependent on wetlands during their life cycle. Many of these critical habitats are in high or moderate danger of destruction from development. Nine of the state's 15 bat species and 30% of Kentucky's 242 species of fish are considered rare.

Efforts to protect and assist in the recovery of some rare species are underway in Kentucky. A federal/state initiative to restore the bald eagle assisted in producing four nests in 1991 and seven young. Additional projects involving short's goldenrod, red–cockaded woodpecker, and some species of mussels have also been conducted. The Daniel Boone National Forest recently adopted a policy to limit timber harvesting along clifflines to protect bat habitats.

Funding shortfalls continue to affect the state's ability to protect threatened and endangered species habitat. A tax check–off program has provided most of the limited state funds available to aid in nongame research and habitat protection.

Chapter 6
Coal Mining

The environmental impacts of coal mining, one of the state's leading industries, have been better controlled since the enactment of the national Surface Mining Control and Reclamation Act of 1977. While much progress has been made, more remains to be done to reclaim the thousands of acres of abandoned and forfeited mine sites and enforce regulations at the 3,455 coal mining operations active in Kentucky.

Coal Facts Coal continues to be mined at record levels in Kentucky. In 1990, 179.4 million tons were mined, an increase of 43% since 1970. Coal employment, however, has steadily declined due to advancements in technology and the use of highly mechanized equipment.

About 75% of the coal produced in Kentucky was mined in the Eastern Coalfield where the coal is lower in sulfur content. The remainder was mined in the Western Kentucky Coalfield. During the last seven years, underground mining has steadily increased both in the Eastern and Western coalfields. Underground mining now accounts for more than 60% of the coal mined in Kentucky.

Ten companies own nearly half of the state's coal reserves. About 29.9 billion tons of the state's 105 billion tons of bituminous coal resources are classified as recoverable. To date, an estimated 11.7 billion tons have been mined.

Regulation of Coal Mining While coal mining has been regulated to some degree in Kentucky since 1966, it was not until the enactment of the federal Surface Mining Control and Reclamation Act of 1977 that regulation was addressed on a national basis. In 1977, Kentucky began implementing key provisions of the federal law and in 1982 assumed primary authority to carry out the program.

Since 1978, thousands of coal mining permits have been issued in Kentucky covering an estimated 1.2 million acres of land. Currently, there are 2,006 surface mines and 1,449 underground mines permitted in the state, disturbing approximately a quarter million acres of land. About 75% of the land permitted for mining operations is in Eastern Kentucky.

Mining is considered a temporary use of the land which must be restored to its original condition. Of the 1.2 million acres permitted for mine operations since 1978, about half was forestland. About 40% of this land was restored to forest. Approximately 108,000 acres of original hay/pastureland have also been disturbed by mining. Nearly three times that acreage has been reclaimed back to hay/pastureland, revealing a preference by operators and landowners for this post–mining land use. There has been a recent increase in creating fish and wildlife habitat in mine reclamation as well.

Compliance with Kentucky's mining laws and regulations has improved. In July 1991, 61.5% of the coal mine operations were meeting state requirements, an increase since 1987 when only 47% were in compliance. The infusion of $13.5 million in federal funds in 1987 to settle a lawsuit, alleging a systematic breakdown in the enforcement of state coal mining laws, has assisted in improving state enforcement efforts. But many mine sites still continue to impact the environment. Discharges from mining operations and runoff from abandoned mine lands are impacting hundreds of miles of streams, several lakes, and a number of wetlands. In 1991, a record 252 water–related violations were cited at mine sites. But the overall environmental impacts of mining are difficult to assess due to a lack of available data and information.

The state's issuance of noncompliance notices for mine operations and fines collected has remained fairly constant since 1985. A majority of the penalties actually assessed for coal mining violations, however, were written off as not collectible or were negotiated through settlements.

Some coal mining violations have resulted in bond forfeitures. Federal and state laws require that every permitted operation must post a performance bond before mining begins. The bonds are released as various stages of reclamation are achieved. Since 1984, 1,607 bonds covering 36,125 acres were forfeited in Kentucky, representing a bond forfeiture rate of 10.1%. About 59% of this forfeited acreage has been reclaimed. The federal

Office of Surface Mining contends that inadequate bond amounts have limited the state's ability to reclaim these and other mine sites adequately.

In 1990, 1,500 citizen complaints were received regarding mining operations. More than 70% of the complaints received by the state involved mine–related blasting and its impact on homes and domestic water supplies. While current laws address property damage caused by surface mining, replacement or compensation to landowners from damage caused by underground mines, known as subsidence, is less clear.

Meanwhile, 34 counties are participating in a state mine subsidence insurance program for homes and other structures. Currently, 42,000 policies are in effect. Of the 245 claims filed since the program began in 1986, only 15 have resulted in settlements.

Abandoned Mine Lands Kentucky has an estimated 100,000 acres of pre–law (1977) abandoned mine lands. Since 1978, about 10,000 acres have been reclaimed using federal Abandoned Mine Land Funds. This program is financed through a surcharge on coal production. Since 1982, Kentucky has paid $298 million into the fund and has received back $196 million (about 65%) to reclaim old sites. Another $38 million has been used by the federal Office of Surface Mining to address mine–related emergencies in Kentucky.

The costs of reclaiming pre–law abandoned mine sites are estimated to be in the millions of dollars. In addition, thousands of acres of mine land have been left unreclaimed since 1977 due to surety insolvencies, inadequate bonds, and poor reclamation. Much of this mine land does not qualify for federal Abandoned Mine Land Funds. In 1987, five surety companies, representing nearly 300 surface mining bonds, failed. The state won an $8 million claim against these companies in 1989 and has collected $2.2 million to date.

Alternative means of addressing the problem of old mine sites, such as providing industrial incentives to remine and reclaim them, have been discussed at length both in Kentucky and at the national level. Remining has yet to be practiced extensively due to industry concerns regarding their ability to reclaim these sites to meet environmental standards, particularly for water quality. A proposed 200–acre remining operation, currently under review by the state, should serve to better demonstrate the problems and benefits of coal remining.

Lands Unsuitable for Mining Less than 2% of the permit applications for coal mining have been denied by the state. Denials are primarily due to technical problems or bond deferrals. A permit can also be denied if the proposed operation is in an area designated unsuitable for mining.

Citizens may petition the state to have lands designated unsuitable for coal mining. Since 1983, two of the 15 petitions filed have resulted in state rulings designating approximately 13,400 acres as unsuitable for mining in Kentucky. Most petitions are denied due to technical deficiencies.

Some states are providing technical assistance to help petitioners better articulate concerns and identify relevant data, so the petition can be judged on its merit rather than dismissed due to a technical deficiency. Such an initiative may assist in making the lands unsuitable process a more viable part of the state’s mining program.

Chapter 7 Energy

Kentucky has vast energy resources that contribute to meeting both state, national, and, in some cases, international demands. The recovery and conversion of many of these resources, however, impacts the environment. It is, therefore, important to review energy production and consumption trends to better understand environmental conditions in the state.

Consumption Residential, commercial, and industrial energy consumption in Kentucky has increased 81% during the last three decades. Industries consume most of the energy used in the state, especially petroleum and coal–fired electricity. Individual households now use 92% more energy per person than was used in the early 1960s, a reflection of the state's increasing standard of living.

The amount of fuel used for transportation has nearly tripled during the last 30 years in Kentucky as a result of increasing population and greater mobility. While the average number of automobile miles each Kentuckian travels yearly has increased nearly 3,000 miles since 1965, personal gasoline consumption has remained fairly constant during this time period. This is primarily the result of greater automobile fuel efficiency.

Energy Production and Supplies: Nonrenewable Fuels Kentucky's nonrenewable energy supplies include coal, petroleum, and natural gas.

The state has nearly half of the U.S. coal reserves and currently supplies 20% of the nation's demand for coal. The state's coal production continues to increase, and reached record levels in 1990. Much of this coal supplies the state's power plants which produce 94% of the electricity consumed in Kentucky. Increasing restrictions on sulfur emissions from coal burning power plants are aimed at reducing acid rain precursors. These mandated controls may affect the future production of Kentucky coal, particularly in the western region of the state where coal is higher in sulfur content.

Kentucky also produces significant amounts of oil and natural gas. State petroleum production peaked many years ago and has declined since, ranking Kentucky 21st out of 31 states with oil production. While oil wells have been drilled in all counties of the state, ten counties account for 70% of the oil currently produced. Most of the state's 20,000 oil operations are stripper wells that produce less than ten barrels of oil a day.

Natural gas is produced through 10,000 wells in 33 counties, although 13 counties account for 92% of the state's production. Natural gas production has remained fairly constant in Kentucky in recent years. While the amount produced accounts for 40% of the state demand, most of Kentucky's natural gas is shipped out–of–state via pipeline for consumption elsewhere.

Energy Production and Supplies: Renewable Fuels Kentucky has the potential to produce sizeable amounts of energy from renewable resources such as wood and agricultural products. Nationwide, renewable resources only meet 4% of U.S. energy demands, although some experts predict they could supply 28% by the year 2030.

The use of forests for wood fuel is increasing in the state and is at its highest level since 1974. Thirty–five Kentucky industries use wood for fuel. The use of wood for energy will likely increase as more efficient equipment is developed and opportunities to use wood as a supplement for coal are advanced.

The use of grain to produce the gasoline supplement ethanol has increased significantly since the late 1970s. In Kentucky, 19% of the gas consumed during 1990 was ethanol blends. While this was a decrease since 1989, the state's ethanol consumption is still well above the national average of 6%. Kentucky's two ethanol plants are not presently in production due to costs and other economic factors. This may change as the nation shifts its dependence from foreign oil imports and seeks energy alternatives.

Many Kentuckians are not aware that 6% of the electricity consumed in the state is generated by hydropower. Seven plants on six waterways are producing electricity at their greatest levels since 1965. The active use of solar energy, another renewable resource, is somewhat limited in Kentucky due to climate and terrain. Instead, the state is educating homebuilders and the public about the use of passive solar techniques which don't require expensive investments and can result in significant energy savings.

An often overlooked energy resource is energy that is wasted. An estimated 25% of the energy used by Kentucky homes, businesses, and industries is wasted due to inefficiency and overconsumption. Some industries and businesses have made efforts to improve energy efficiency and conservation. Several state schools and hospitals have conducted energy audits which resulted in energy savings of 27% to 34% of their previous use. Unfortunately, fuel costs usually drive energy conservation and since Kentucky, as well as the nation, has relatively low energy rates compared to other industrialized countries, energy conservation has not been fully adopted as an energy resource.

Energy Costs Kentucky is using more energy than ever before and is paying more for it. Energy rates for coal, natural gas, and petroleum have increased from 300% to 500% since 1970, although rates have declined somewhat since 1985.

The per capita energy cost in Kentucky during 1990 was $1,719, about 4% more than the national average primarily due to intensive energy use by some of the state's industries. The most expensive fuel was petroleum, followed by natural gas.

Energy rates in Kentucky reflect inflation as well as the costs to recover nonrenewable resources and convert them to fuel. Minimizing some of the environmental impacts caused by burning fossil fuels has been achieved by installing pollution controls, including scrubbers on 17 of the state's 58 coal–fired units. Additional controls at other power plants, required under the national Clean Air Act Amendments of 1990, are estimated to cost millions and increase electric rates in Kentucky by 12%. Presently, however, Kentucky has some of the lowest electric rates in the nation due to its abundant coal supplies.

Energy Strategies Kentucky's draft energy strategy focuses on using the state's energy resources to the fullest potential while ensuring an abundant and economical supply for Kentuckians. The plan promotes clean coal technologies to reduce power plant air pollution emissions and greenhouse gases in an effort to maintain markets for Kentucky coal. The state's other energy resources are considered in the plan as well, although not as extensively as coal.

The Kentucky draft energy plan is also critical of the National Energy Strategy proposed by the Bush Administration. It charges that the strategy fails as a national policy by not setting a goal to reduce U.S. dependence on foreign oil. Currently, the U.S. imports about 42% of its oil from foreign countries. The state recommends a greater emphasis on coal for meeting future national energy demands. The strategy has also been criticized by many for its lack of focus on energy conservation and promotion of nuclear energy.◆

Overview

"We will no longer accept the argument that we must choose between jobs or a clean environment. We must have jobs and a clean environment if our state is to succeed now and in our future. Our administration will work cooperatively to make Kentucky a green state. We will seek to meet the highest level of protection so people will want to live, work, and play in Kentucky."

Governor Brereton C. Jones
Platform for Environmental Protection, 1991

Kentucky's environment was subjected to years of abuse prior to the enactment of state and federal pollution control laws in the 1970s and 1980s. In 1970, for example, 70% of the streams and rivers monitored in the state were polluted. Thousands of waste dumps were scattered across the state leaking toxic and hazardous pollutants into the groundwater. Air pollution spewed from smokestacks and automobiles, damaging property and health. Illegal coal mines scarred the landscape and contributed to the pollution of many small mountain streams.

Today, many of the flagrant abuses to the environment have been brought under control. Kentucky's rivers and streams are cleaner. The air is less polluted than it was two decades ago. Hundreds of waste dumps have been closed and cleaned up. And illegal mining has virtually been eliminated. Kentucky's environment is cleaner and safer than it was in the 1970s.

But the job is far from over. Kentucky is now confronted with the need to continue this progress while dealing with new, more complex issues with fewer resources. Today, Kentucky's environment faces uncertain times given the state of the economy and the public and private resources available to address pollution concerns. Because of these factors, the continual review of environmental progress and problems is more critical than ever. It is only through the periodic assessment of environmental trends and conditions that Kentucky can truly determine whether the investments it makes are accomplishing results.

Assessing Environmental Quality and Monitoring Status

While conducting this assessment, the Environmental Quality Commission found that in several cases it was only able to develop a general trend analysis on the status of the state's air, water, and natural resources. Data and information were either unavailable, not collected consistently over the years, inaccurate, or inaccessible through current computer systems and programs to draw more specific conclusions. For example, Kentucky does not track the status of cleanups at waste sites; statewide air emissions data is currently inaccessible under current data management systems; water quality monitoring data from surface mine sites is reported inconsistently from year–to–year; groundwater data is collected by several agencies and seldom shared; and historical inspection, compliance, and penalty assessment data for environmental programs are incomplete.

Lack of consistent data collection by resource agencies and the ability to access information are serious problems that must be addressed if Kentucky is to move forward in adequately evaluating environmental issues and progress. The development of statewide environmental indicators, provided in this report and summarized in Appendix A, should promote the better collection and use of data. Environmental indicators will also help to identify important environmental issues and provide the basis for setting priorities.

The need to develop compatible databases and systems to better manage information and determine the cumulative impacts of air, water, and waste pollution on the environment in any given area is of equal, if not greater, importance. The updated and improved use of the state's Geographic Information System would greatly assist in this effort, although it will require continued commitment of resources as well as cooperation among state agencies, universities, and others involved in data collection and analyses.

The Costs of Environmental Protection

Kentucky has achieved improvements in environmental quality during the past two decades, but these have not come easily or cheaply.

Government and private costs to protect the environment have increased dramatically over the years. Kentucky, like most states, has assumed authority to carry out federal air, water, waste, and mining laws and regulations. The costs to Kentucky taxpayers for these and other programs continue to increase as various provisions are implemented, technical requirements become more complex, and more staff and equipment are added to enforce additional rules and regulations **(Figs. 1, 2, 3, and 4)**.

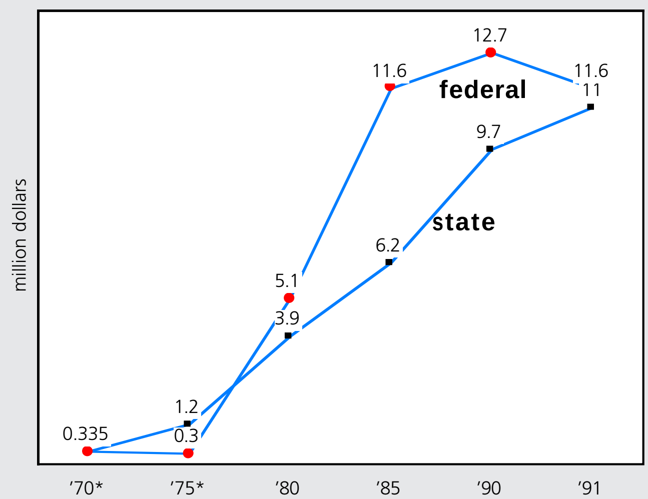
For example, the state cost of regulating surface mining in Kentucky nearly tripled over the last 11 years, from $3.9 million in 1980, to more than $11 million in 1991. These increasing costs recently led the legislative Interim Agriculture and Natural Resources Committee to consider turning the authority to regulate surface mining in Kentucky back to the federal government.

The costs of protecting the environment have greatly increased during past two decades. Kentucky, like most states, has assumed authority to carry out federal environmental laws and regulations.

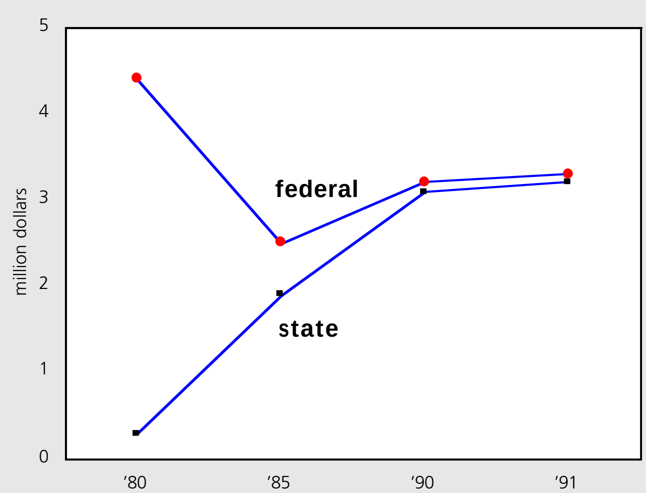
Figure 1

State and Federal Budgeted Expenditures on Kentucky's Surface Mining and Abandoned Mine Land Programs (selected years)

Surface Mining



Abandoned Mine Land



*Breakdown between state expenditures for surface mining programs and abandoned mine land programs was not available. They are combined for 1970 and 1975.

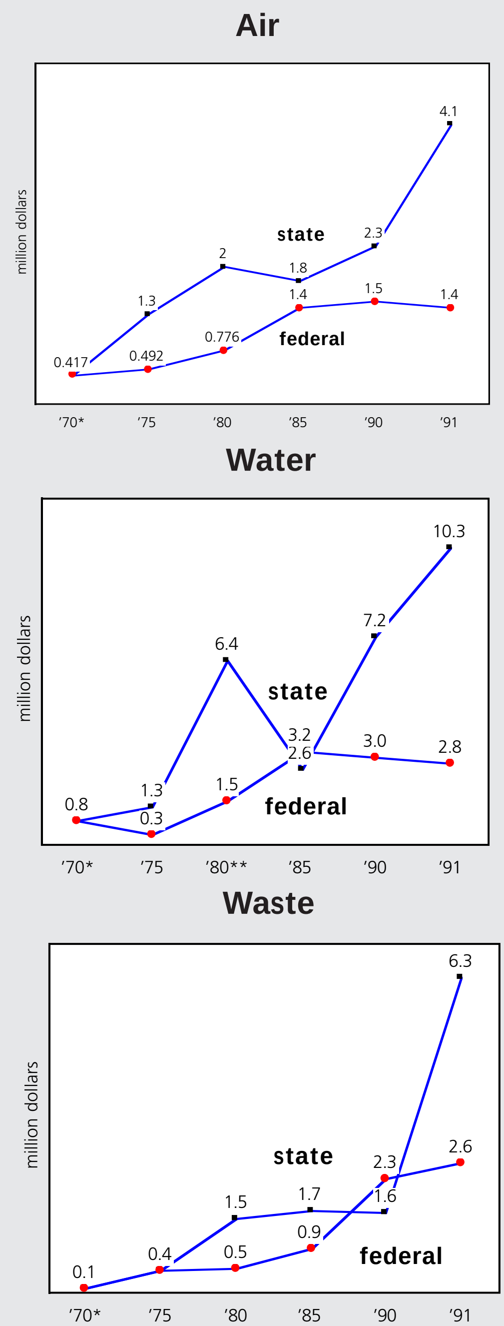
Source: Kentucky Executive Budget Documents for 1970, 1975, 1980, 1985, 1990, 1991 unless noted otherwise

As the gap between state and federal funding for environmental programs has continued to widen, Kentucky has sought alternative funding sources. Recently the state increased industry fees to process air, water, and waste permits. However, costs associated with compliance and enforcement activities continue to stress budgets.

The federal Clean Air Act Amendments of 1990, expected to cost millions of dollars to implement, recognized the lack of adequate resources needed to carry out the provisions of the act. Congress incorporated language in the act to provide for the collection of emissions fees from air pollution sources to cover the costs of program development, permitting, and enforcement. The Kentucky Natural Resources and Environmental Protection Cabinet proposed, in the 1992 General Assembly, an air emissions fee of $18 to $20 a ton for major sources, which was expected to raise $6 million annually and fund approximately 71% of the Division for Air Quality's 1993 and 1994 budget. The legislature, however, cut this fee to $8 per ton and provided general funds to cover the remainder of the Division's expenses.

The trend toward having the regulated industries pay for environmental programs will likely continue as Kentucky and the nation face increasing costs but fewer resources to protect the environment.

Figure 2
State and Federal Expenditures on Kentucky's Environmental Programs (selected years)

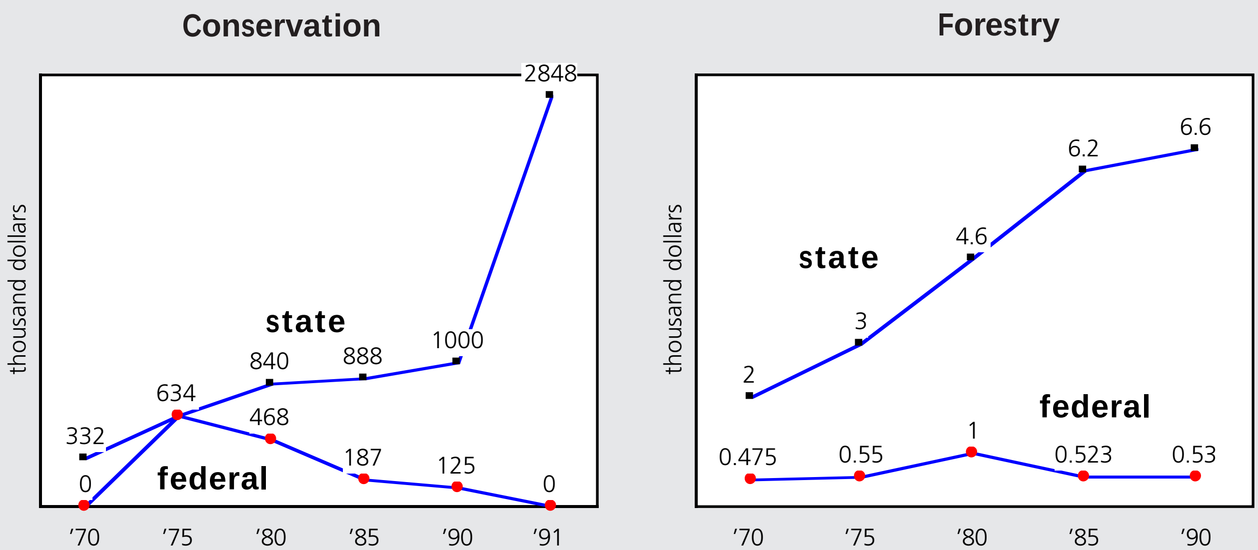


** Breakdown between federal and state not available.*

***$8 million was budgeted for Community Flood Damage Abatement Program. This was subsequently moved to capital construction budget.*

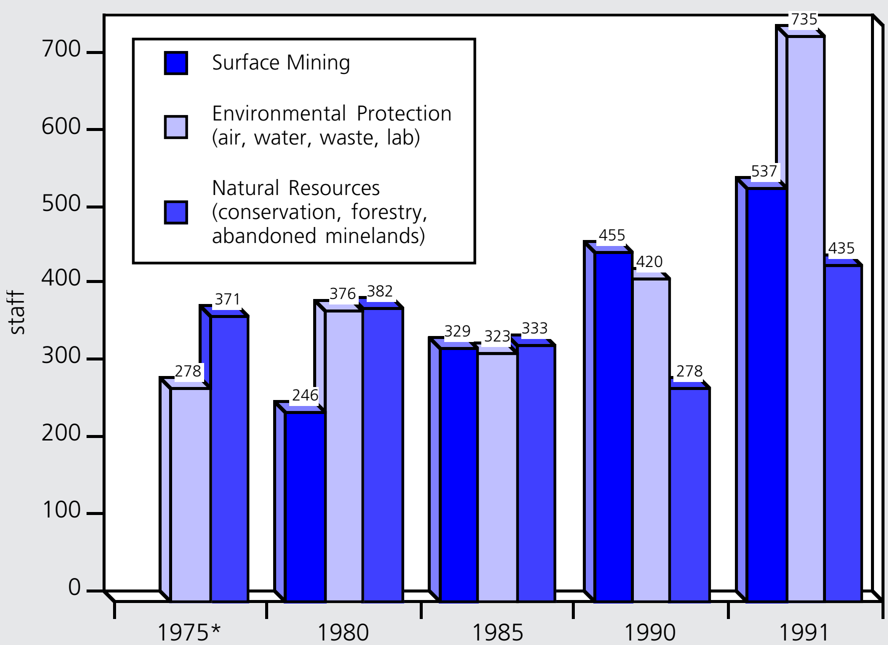
Source: Kentucky Executive Budget Documents for 1970, 1975, 1980, 1985, 1990, 1991 unless noted otherwise

Figure 3
State and Federal Expenditures on Kentucky's Natural Resource Programs



Source: Kentucky Executive Budget Documents for 1970, 1975, 1980, 1985, 1990, 1991

Figure 4
Environmental and Surface Mining Program Staffing Trends in Kentucky (selected years)



**1975 staff for natural resources and surface mining combined for a total of 371.*
Source: Kentucky Natural Resources and Environmental Protection Cabinet, 1992

Compliance with Existing Laws and Regulations

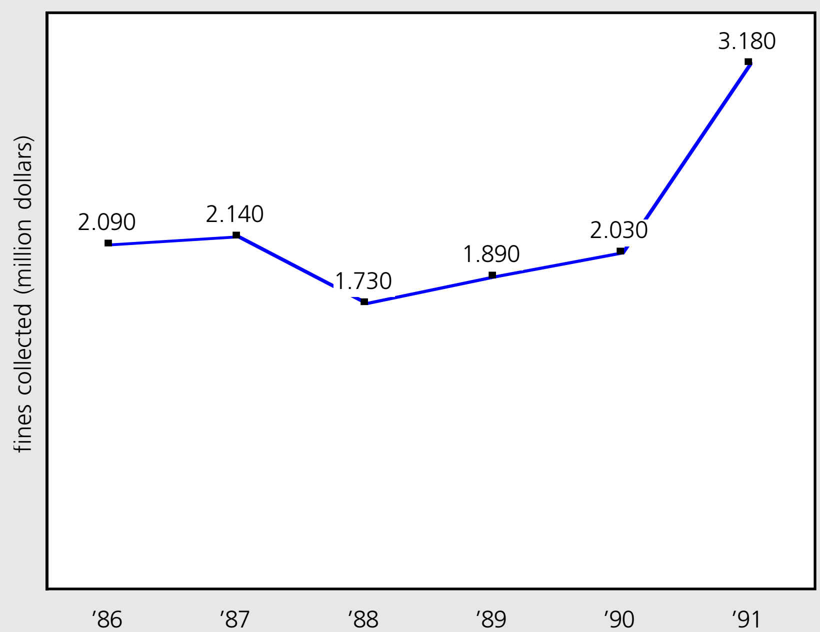
Much of the state costs to protect the environment are associated with enforcement of environmental laws and regulations.

Past and present compliance with environmental laws at coal mines, industrial plants, wastewater treatment plants, landfills, and other facilities largely determines the state of Kentucky's environment today. Environmental violations have been issued at record levels in recent years and overall compliance with the state's air, water, waste, and mining laws appears to be improving.

Penalties collected for environmental violations rose significantly in the past year from $2.03 million in 1990, to $3.18 million in 1991, primarily due to the collection of a major penalty assessment against Ashland Oil **(Fig. 5)**.

However, not all fines assessed are collected for various reasons including bankruptcies or legal challenges. For example, 10% of the state environmental fines assessed since 1986 were collected. The Cabinet is currently attempting to accurately assess penalty collection rates and trends for air, water, waste, and surface mining.

Figure 5
Environmental and Coal Mining Fines Collected in Kentucky



Note: Includes air, water, waste, and coal mining penalty collections
Source: Kentucky Natural Resources and Environmental Protection Cabinet, Division of Hearings, 1992

Much of the state's cost to protect the environment is associated with the enforcement of laws. Overall compliance with state laws appears to be improving.

The number of state environmental and coal mining legal cases pending action in Kentucky as of February 1992 was 7,077 **(Fig. 6)**. Many cases are awaiting action due to a lack of state resources. Currently, Kentucky has 21 and 49 attorneys dedicated to prosecuting environmental and coal mining legal actions, respectively. And state budget cutbacks will likely mean even fewer staff attorneys in the future.

Many air, water, and waste-related violations are resolved through Agreed Orders. Kentucky has promoted the use of such orders to bring facilities into compliance during a certain time period while avoiding expensive and time–consuming litigation. No such process exists for coal mining violations and they are referred to the Cabinet's Department of Law to determine appropriate enforcement action. This may involve penalties, permit revocation, or bond forfeiture. In some cases, such as illegal sites or sites with inadequate reclamation bonds, the state has filed suits to require individuals to reclaim mine sites. During 1991, the courts issued 22 bench warrants to individuals failing to show or comply with court orders to reclaim sites. Thirteen individuals were jailed for being in contempt of court as a result of these actions.

Figure 6
State Environmental Legal Actions

Total cases in 1991	**2,590**
Number Resulting in Criminal Convictions	**1**
Number Resulting in Civil Penalties	**1,124**
1991 Cases Awaiting Resolution	**1,232**
All Cases Awaiting Resolution	**7,077***

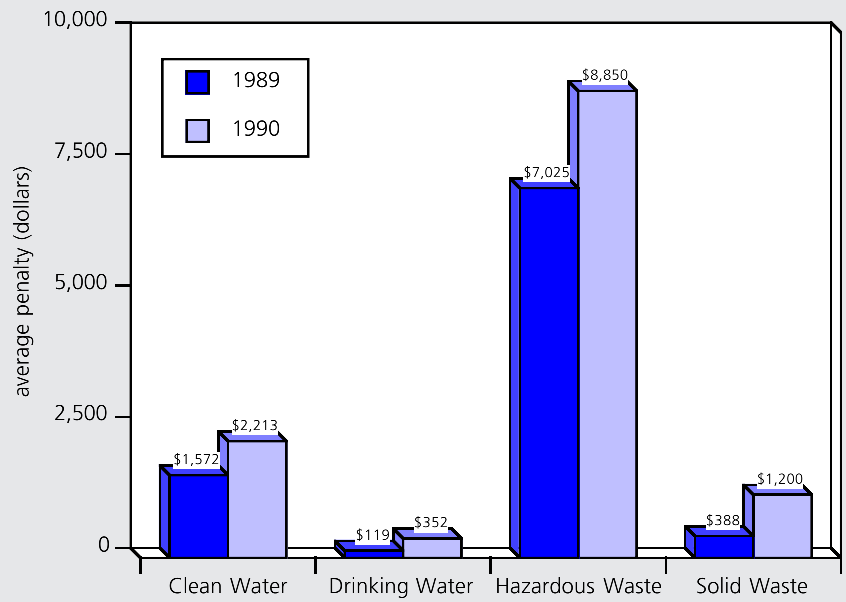
**841 cases deal with air, water, and waste violations. The remainder are coal mining cases.*
Source: Natural Resources and Environmental Protection Cabinet, Department of Law, February, 1992

The number of legal cases against polluters awaiting action number in the thousands. A lack of state resources has limited the state's ability to prosecute cases in a timely manner.

There is a growing sentiment that the level of fines and state actions taken against environmental polluters do little to deter environmental violations. Penalties assessed for air, water, and waste violations vary. For example, the average state environmental penalties in 1990 ranged from a high of $8,850 for hazardous waste violations, to a low of $352 for drinking water violations **(Fig. 7)**. Some assert that it is cheaper to pay the fine than correct or prevent problems.

The average state penalty for water and waste violations varies, but increased between 1989 and 1990.

Figure 7
State Penalty Averages for Water and Waste Violations



Note: Data for average air or coal mining penalties not provided.
Source: Kentucky Department for Environmental Protection, 1991

To strengthen the state's enforcement programs and deter violations, an Environmental Crimes Workgroup was established in 1990 to prepare potential criminal cases for prosecution. The workgroup is a cooperative effort between the Natural Resources and Environmental Protection Cabinet, the Kentucky State Police, the Federal Bureau of Investigation Kentucky Office, the U.S. Environmental Protection Agency, the U.S. District Attorneys in Eastern and Western Kentucky, and the Kentucky Attorney General.

The workgroup has opened 64 cases, six of which have resulted in federal court convictions on criminal charges. The criminal convictions obtained through the work of this group are some of the first successfully prosecuted in the state. In 1991, the state's Attorney General hired four full–time staff to conduct environmental crime investigations. In addition, a detective has been assigned to environmental crime investigations at each of the state's 16 State Police posts.

These efforts will greatly assist in ensuring that "midnight dumpers" and other criminal abusers of the environment are prosecuted to the fullest extent of the law. An FBI environmental crimes hotline (1-800-367-0160) has been established to report illegal or suspicious activities. How effectively the state continues to address environmental violations will be critical in shaping the future of Kentucky's environment. The addition of 41 air, water, and waste inspectors in 1991, for a total of 129, should greatly assist the state monitor compliance with environmental laws and regulations.

Establishing New Strategies and Approaches to Environmental Protection

Environmental programs and the enforcement of state regulations have improved the quality of the environment over the past two decades. The refinement and expansion of these efforts are vital to maintaining improvements.

Kentucky must also look for new ways to solve some of its more pressing environmental problems. This calls for creative and novel approaches that may not necessarily be regulatory in nature.

Cooperative Initiatives Water, air, waste, toxics, natural resource, mining, and energy programs are often implemented separately. The "State of Kentucky's Environment" report reflects the fragmented nature of environmental programs as well as the many institutions that have been created to carry out specific program missions. While Kentucky has made progress in many areas where environmental laws and agencies have been crafted around specific issues, there is a growing need to develop strategies that better integrate and coordinate agency missions and programs to achieve more efficient and effective results.

There are tremendous opportunities to better focus state programs and efforts to achieve greater success. For example, Kentucky is faced with the significant challenge of restoring thousands of miles of streams and rivers. Over the past decade, state water programs have relied primarily on controlling industrial and municipal discharges of pollutants to surface waters, resulting in improvements to many streams and rivers. Investments in municipal wastewater treatment plants and in pollution control technologies have reduced the amount of pollutants impacting Kentucky waterways.

However, more than 36% of streams and rivers monitored in Kentucky and one–third of the 102 public lakes assessed are still impaired by pollution. Runoff from farmland and mine sites continues to pollute streams and lakes. Groundwater in Kentucky remains virtually unprotected even though it supplies 20% of Kentucky's drinking water needs. Deterioration of stream buffer zones, known as riparian areas, continues to impact water quality. Kentucky has lost hundreds of stream miles to channelization and modification activities, severely affecting small stream values. While new programs may be in order to address these issues, a new approach to managing water resources is also needed.

The "whole river basin management" approach provides an opportunity to focus state programs and efforts on the water problems occurring in each of the state's 13 major rivers and the streams and watersheds making up those basins. Targeting the state's resources to assess problems and promote cooperative and integrated solutions among state and federal agencies and local communities is the focus of the "whole river basin management" approach.

The Environmental Quality Commission has recommended that "whole river basin management" demonstration projects be initiated in Kentucky to assess its feasibility. Such an approach can assist in breaking down the institutional barriers that limit the effectiveness of current efforts and may prove to be a practical tool to clean up the rivers and streams of Kentucky.

Reducing Pollution The need for a more holistic approach to environmental protection has become evident because environmental programs often result in the transfer of pollutants from one medium to another. For example, while pollution control technologies have been effective in reducing industrial air emissions and stream discharges, they also have resulted in the increasing generation of hazardous and toxic process wastes needing treatment or disposal. Greater coordination among waste, water, air, and mining programs is critical if Kentucky is to control cross–media pollution.

The prevention of pollution is also receiving increasing attention. Individual, household, business, and government efforts to reduce and recycle solid wastes are becoming more common throughout Kentucky. And national efforts to expand historical programs that control industrial pollution at the "end of pipe" or stack to include pollution prevention at the source have also been initiated in recent years. The federal Pollution Prevention Act of 1990 seeks to encourage and assist industry in reducing the production of hazardous and toxic pollutants.

Several Kentucky industries have effectively reduced, or committed to voluntarily reduce, the generation of toxic substances and hazardous waste through process changes, environmental audits, and greater efficiency. A state waste reduction technical assistance center was recently established to help businesses identify waste reduction options. However, hazardous waste reduction efforts, on average, appear weak and, in some cases, nonexistent. The production of hazardous waste and the release of highly toxic chemicals continues to pose significant risks in Kentucky.

Additional measures to reduce hazardous waste and toxic releases are needed. A state waste reduction goal has been proposed by the Natural Resources and Environmental Protection Cabinet. Waste reduction plans, measurable performance goals, economic incentives to reduce the amount of pollution generated, and mandates for technologically feasible or economically practical pollution prevention practices were included in the proposal presented to the 1992 Kentucky General Assembly. The measure, however, failed to win the support of the Legislature.

Preventing pollution by reducing hazardous wastes and toxic contaminants is a promising approach to achieving a cleaner and safer environment. Pollution prevention can lower costs to industries for the disposal of wastes as well as minimize future liability. The key is to recognize this opportunity and craft a state pollution prevention program that achieves reductions in an effective and equitable manner.

Greater Public Involvement The expansion of roles in environmental protection is also needed. It is apparent that the various state and federal agencies cannot do the job alone. Kentucky must rely more on cooperative partnerships with local governments, the private sector, and individuals to address tough environmental problems.

The role of communities in addressing environmental concerns has grown tremendously over the last ten years. Many counties and cities are responding to local environmental concerns by initiating a variety of measures including recycling programs, greenspace protection, planning and zoning, solid waste planning, and hazardous waste ordinances. A survey conducted by the Environmental Quality Commission in 1991 revealed that 90% of the city and county officials responding indicated an interest in playing a greater role in the protection of the environment, given adequate information, technical assistance, and funding.

Kentucky must move ahead in promoting individual, community, and business actions to address environmental problems. A strong program of education and technical assistance is critical in this regard.

Reaching Common Ground During the last several years, Kentuckians have become more personally involved in resolving environmental problems facing their communities. Many local groups have organized to promote recycling, initiate stream and roadside cleanups, and educate the public about environmental concerns. Others have formed around specific issues such as the siting of a landfill, coal mining impacts, or a contaminated waste site. Public awareness and concern has moved environmental issues to the forefront of Kentucky's and the nation's priorities.

Grassroot efforts to protect the environment have increasingly resulted in conflicts between developers and local citizen groups. Protecting the environment while promoting economic growth will continue to challenge the state, especially in times of economic uncertainty. Existing decision–making processes often do not provide the mechanisms needed to facilitate solutions to environmental disputes. State efforts to promote alternative methods to resolve environmental conflicts that balance economic and environmental interests are expanding in Kentucky. The use of environmental mediation and conflict resolution may prove to be effective tools when traditional processes fail to deal with the real issue of the dispute. The further use of consensus building and policy dialogues should also be promoted in the development of state environmental policies, programs, and regulations.

Setting Goals and a Statewide Policy for a Healthy Environment

Everyone hopes that in five, ten, or 15 years Kentucky's air and water will be clean and the state's natural resources will be abundant and diverse. But realistically, what level of environmental protection can Kentucky hope to achieve and how can it meet those goals? This question remains to be answered. While the state has developed an Environmental Management Plan, which has been successful in guiding specific air, water, and waste programs, there is no overall statewide strategy to protect the environment in Kentucky.

There is a need to more clearly define both short and long–range environmental goals and adopt a statewide strategy or action plan to achieve those goals. In addition, a policy that promotes an environmental ethic in all state agency program missions and development projects would certainly go a long way to ensure a brighter future for the environment. Many are calling for sustainable development in Kentucky—promoting economic development in concert with the state's natural resources—which is critical to maintaining a high quality of life in Kentucky.

This report calls attention to both the progress and problems confronting Kentucky's environment. It is up to state policy makers, government agencies, businesses, and citizens alike to determine what action is necessary to meet the state's environmental challenges. It is the Environmental Quality Commission's fervent hope that all Kentuckians will join together to collectively solve the problems described in this report so that future generations will inherit a cleaner and safer environment.

Chapter 1

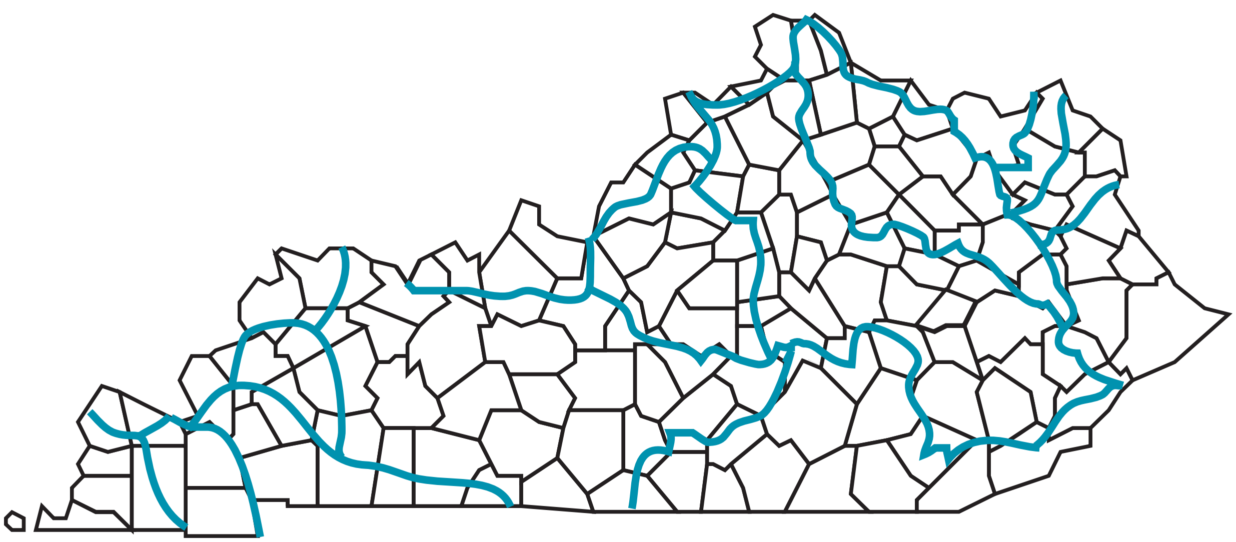
Water Resources

Water Resources

Kentucky's water is cleaner than it was 20, or even ten, years ago. Public and private sector investments to protect water resources are paying off. Many streams in the state have improved, some dramatically as a result of pollution control laws and regulations.

That's the good news. The bad news is that poor water quality is still impacting the use of one–third of the rivers and lakes monitored in Kentucky. To determine the status of Kentucky's water resources, data and information collected by federal and state agencies was reviewed. This chapter presents general findings on the progress being made toward achieving the clean water Kentuckians need for drinking, recreation, a sound economy, and a healthy environment.

Figure 1
Kentucky River Basins



Source: University of Kentucky, Department of Geography, 1992

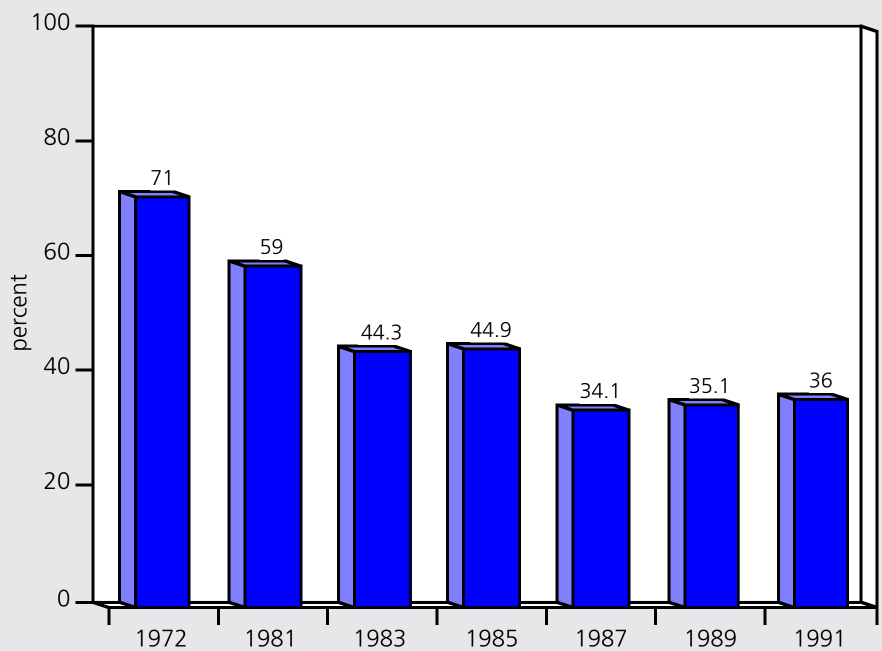
Rivers and Streams

Improvements Made in Restoring Rivers and Streams; 36% of Stream Miles Assessed Still Cannot be Used for Swimming, Fishing, or Drinking

Kentuckians enjoy the benefits of an estimated 89,431 miles of streams. These surface streams help form the state's 13 major river basins **(Fig. 1)**. The quality of the state's river resources is currently evaluated through 45 monitoring stations. These stations, operated by the Kentucky Division of Water (DOW), along with data collected by other state and federal agencies, provide some insight into the overall degree of stream pollution and the ability of these waters to meet various uses including fishing, swimming, and drinking water supply.

While progress has been made in improving water quality, 36% of the 10,659 miles of streams and rivers monitored in the state during 1991 were still impacted by pollution **(Fig. 2)**. Approximately 55% of the 3,397 miles of streams assessed could not fully be used for swimming and 20% of the 9,174 stream miles assessed did not meet the nation's fishable goal **(Fig. 3)**. In addition, nearly 93% of the Ohio River bordering Kentucky could not fully be used for swimming and 43% did not meet the fishable goal. Rivers and streams are impacted by a range of pollutants including improperly treated sewage, industrial discharges, toxics from leaking landfills, and runoff from farmland and coal mining activities.

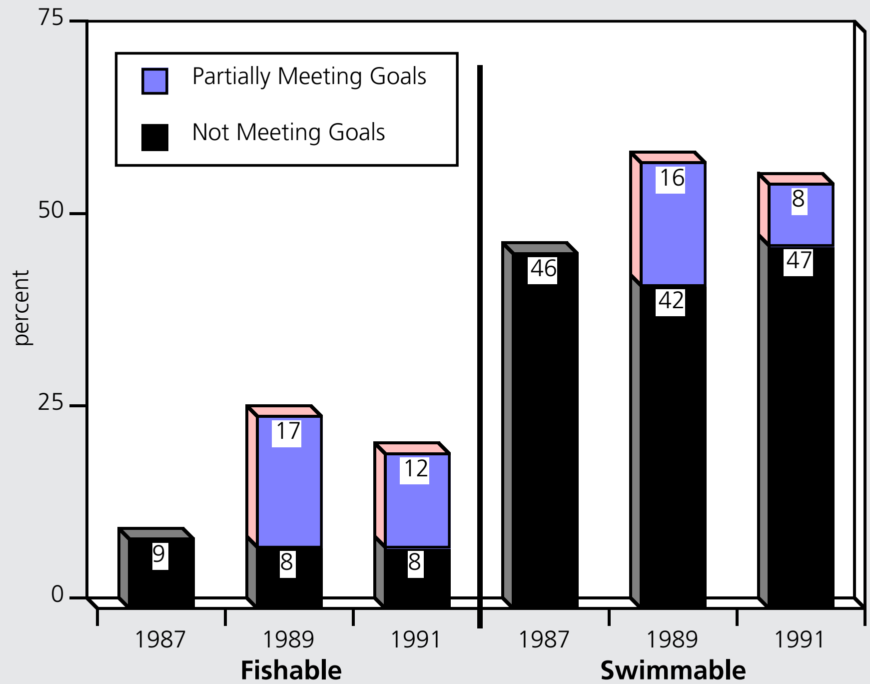
Figure 2
Percentage of Monitored Streams in Kentucky Impaired by Pollution



Source: Kentucky Division of Water 305(b) Reports 1982-1992; U.S. Environmental Protection Agency STEP report, 1972

Trends show that progress has been made in cleaning up Kentucky waterways. Thirty–six percent of the streams and rivers monitored, however, are still impaired by pollution.

Figure 3
Percentage of Kentucky Streams and Rivers Assessed Not Meeting Fishable and Swimmable Goals

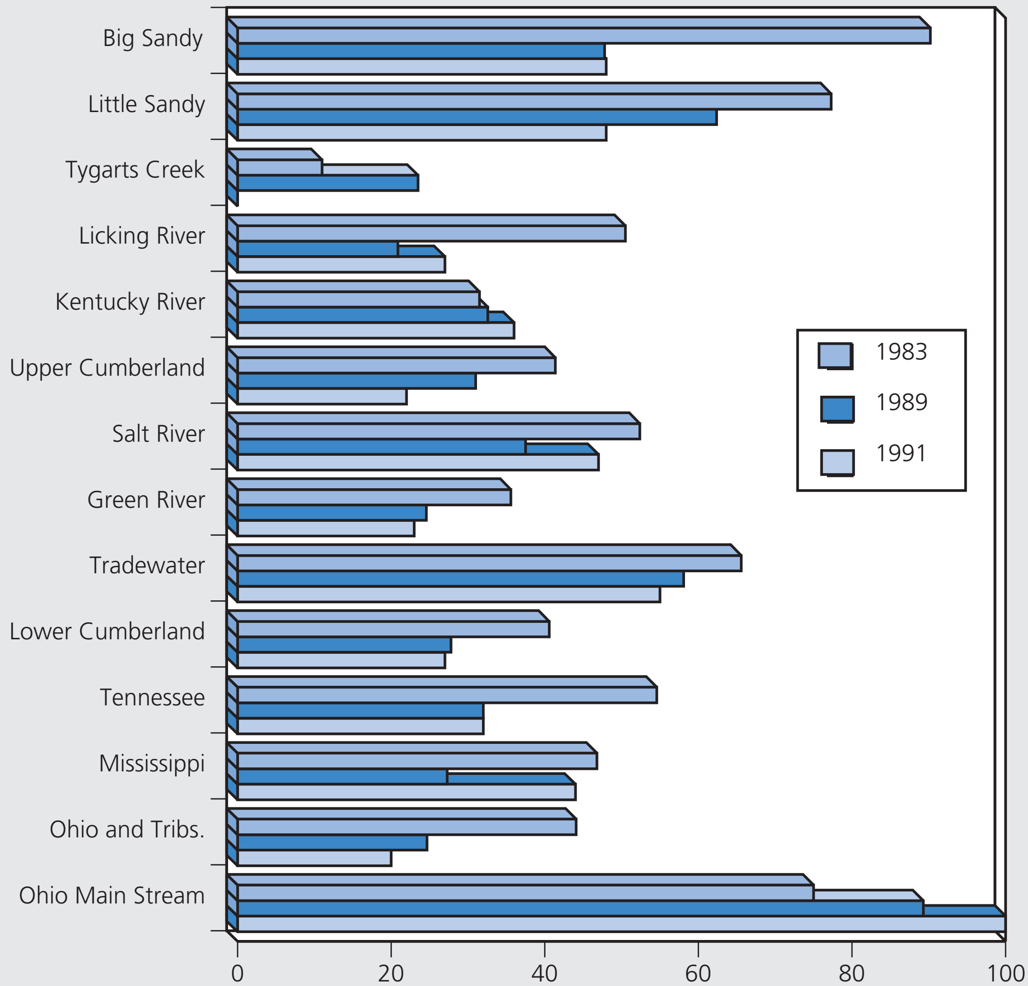


Note: Earlier data not available
Source: Kentucky Division of Water, 305(b) Reports, 1988-1992

Approximately 55% of the stream miles asessed in Kentucky during 1991 did not meet the nation's swimmable goal and 20% did not fully support fishing.

Federal and state government efforts to restore and maintain water quality have primarily emphasized the control of industrial and municipal discharges into waterways. Under the federal Clean Water Act of 1972 and state law, the discharge of pollutants into the waters of the Commonwealth is prohibited unless a Kentucky Pollutant Discharge Elimination System (KPDES) permit is issued. These permits limit the amount of pollutants discharged, require monitoring, and must be renewed at least once every five years. As of March 1992, KPDES permits were in effect for 3,023 industrial and municipal facilities, and approximately 4,100 coal operations. Controlling discharges through KPDES permits and enforcement of state water laws and regulations has improved the quality of some streams and rivers across the state, but much more remains to be done **(Figs. 4 and 5)**.

Figure 4
Percentage of Streams Assessed in Kentucky with Some Degree of Pollution by River Basin



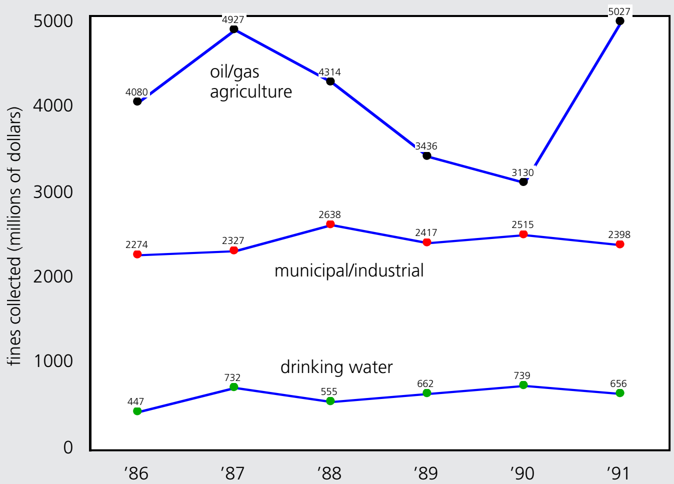
Source: Kentucky Division of Water, 305(b) Reports, 1982–1992

State efforts to restore and enhance water quality have primarily emphasized the control of industrial and municipal wastewater discharges. These controls have led to improved water quality in some streams and rivers, but much more remains to be done.

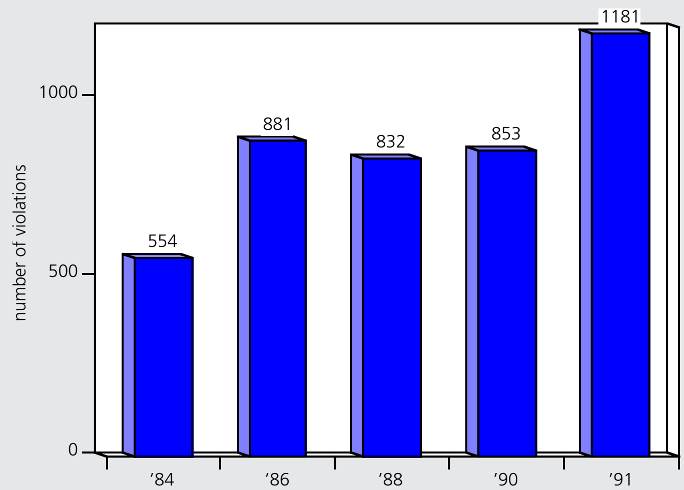
Figure 5

State Water Enforcement Activities

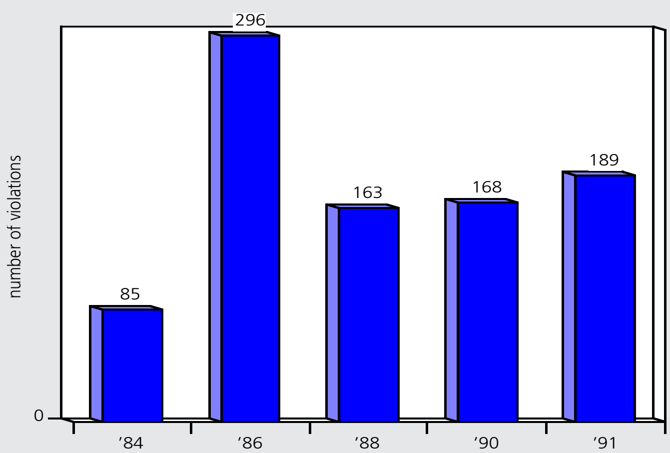
Inspections*



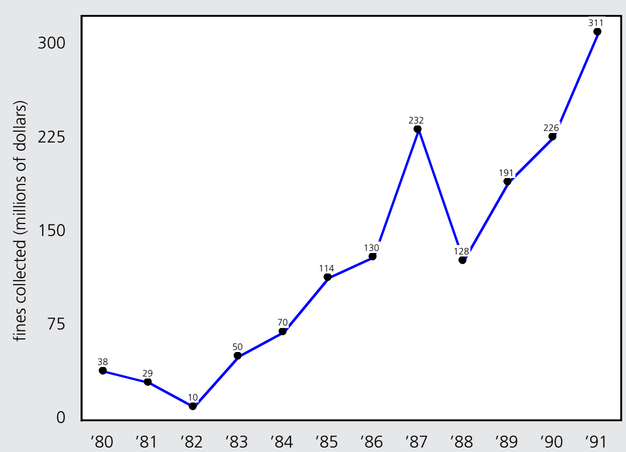
Violations



Agreed Orders**



Fines Collected



Inspections also include:

	1986	1987	1988	1989	1990	1991
biomonitoring				*35*	*35*	*35*
community asst.	*20*	*22*	*20*	*20*	*20*	*26*
flood plain	*92*	*64*	*117*	*126*	*207*	*170*
dams	*510*	*506*	*468*	*312*	*183*	*337*
total	*7,506*	*8,661*	*8,188*	*7,131*	*6,956*	*8,768*

***An Agreed Order is a contract between the violator and the state that outlines the violations, appropriate remedial measures, and civil penalties.*
Source: Kentucky Division of Water, 1992

State water discharge permits are in effect for more than 3,000 municipal and industrial facilities. Enforcement of state water regulations and permit requirements have assisted in improving water quality in Kentucky streams and rivers.

Municipal and Industrial Discharges to Streams

Wastewater Treatment Plant Discharges Among Leading Sources of Water Pollution; Upgrading Plants Results in Water Quality Improvements

Wastewater discharges are among the leading sources of stream and river pollution in the state **(Figs. 6 and 7)**. Discharges of improperly treated sewage from poorly maintained and operated wastewater treatment plants cause 29% of the pollution problems in Kentucky's streams and rivers.

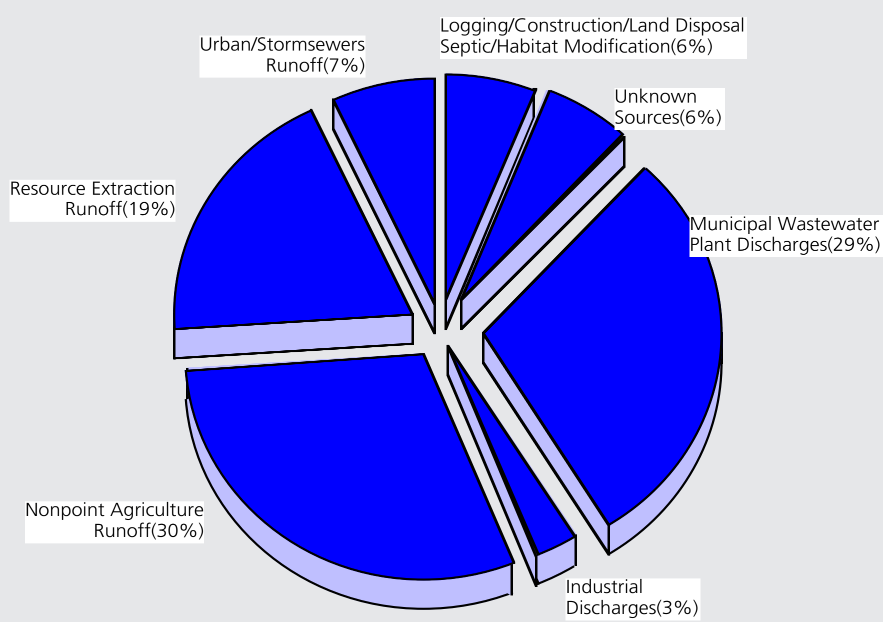
Efforts to upgrade wastewater treatment plants have resulted in some major improvements to the health of streams and rivers during the past decade. Since 1974, $534 million in U.S. Environmental Protection Agency (EPA) construction grants, along with state and local matching dollars, have been invested to improve wastewater treatment plants throughout the state **(Fig. 8)**.

Of the state's 258 municipal wastewater treatment plants (WWTPs), 84 have been upgraded to provide secondary treatment which removes solids and 90% of the organic matter. Another 109 have advanced secondary treatment. Sixty–five municipal WWTPs achieve tertiary treatment. Tertiary treatment provides more advanced cleaning of wastewater by removing nutrients such as phosphorous and nitrogen.

These improvements have led to fewer violations of water quality regulations. The percentage of municipal WWTPs in "significant noncompliance" with their discharge requirements decreased from 30% in 1982, to less than 15% in 1989. Significant noncompliance is defined as chronic violations of discharge limits, discharges dangerous to public health, or failure to meet compliance schedules and reporting requirements.

Figure 6

Sources of Pollution to Rivers and Streams in Kentucky (1991)



Source: Kentucky Division of Water; 305(b) Report, 1992

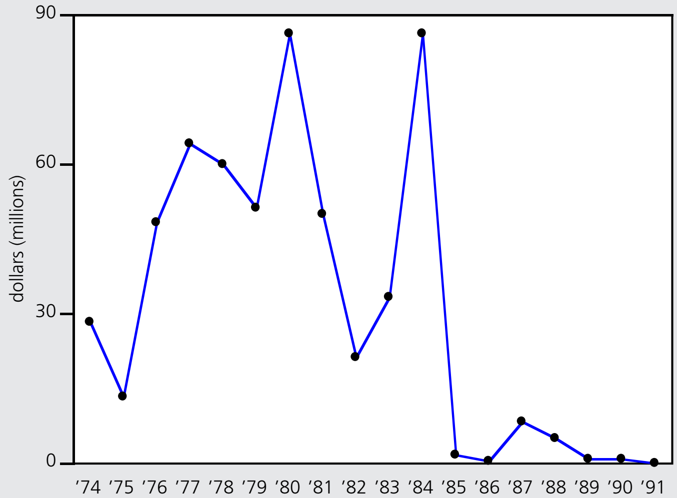
Nonpoint source runoff pollution from agriculture, logging, mining, and urban activities contribute 62% of the pollution problems in streams and rivers. Discharges from municipal wastewater treatment plants and industries cause 32% of the water pollution problems in Kentucky.

Figure 7
Sources of River Pollution in Kentucky

River Basin	Point Sources			Nonpoint Runoff Sources						
	Municipal Wastewater	Industiral	Toxics	Agriculture	Mining	Urban	Oil and gas	Septic tanks and land disposal	Logging	Construction
Big Sandy	●*			●*	●*	●	●	●	●	
Little Sandy	●*			●*	●		●*	●*		
Tygarts Creek	●			●		●		●	●	●
Licking River	●*		●	●*	●	●*	●	●	●	●
Kentucky River	●*	●	●	●*	●*	●*	●*	●	●	●
Upper Cumberland	●*	●*	●	●	●*	●		●	●	●
Salt	●*	●	●	●*		●*		●*	●	●
Green	●*	●*	●	●*	●*	●*	●*	●		
Tradewater				●*	●*		●		●*	
Lower Cumberland	●*	●		●*	●				●	●
Tennessee	●	●*	●	●		●				
Mississippi	●*		●	●	●				●	
Ohio and tribs.	●*	●*	●*	●*	●*	●*		●	●	●

** Considered a major or moderate source of pollution*
Source: Kentucky Division of Water and ORSANCO 305(b) Report, 1990-1992

Figure 8
Federal Wastewater Plant Construction Grant Awards* in Kentucky



year	dollars (millions)
'74	28.0
'75	13.0
'76	48.0
'77	64.0
'78	60.0
'79	51.0
'80	86.0
'81	50.0
'82	21.0

year	dollars (millions)
'83	33.0
'84	86.0
'85	1.5
'86	.383
'87	8.0
'88	5.0
'89	.59
'90	.534
'91	0.0

* *Includes state and local matches. In 1991 federal funds were used to capitalize a state wastewater revolving loan program.*

Source: Kentucky Division of Water, 1991

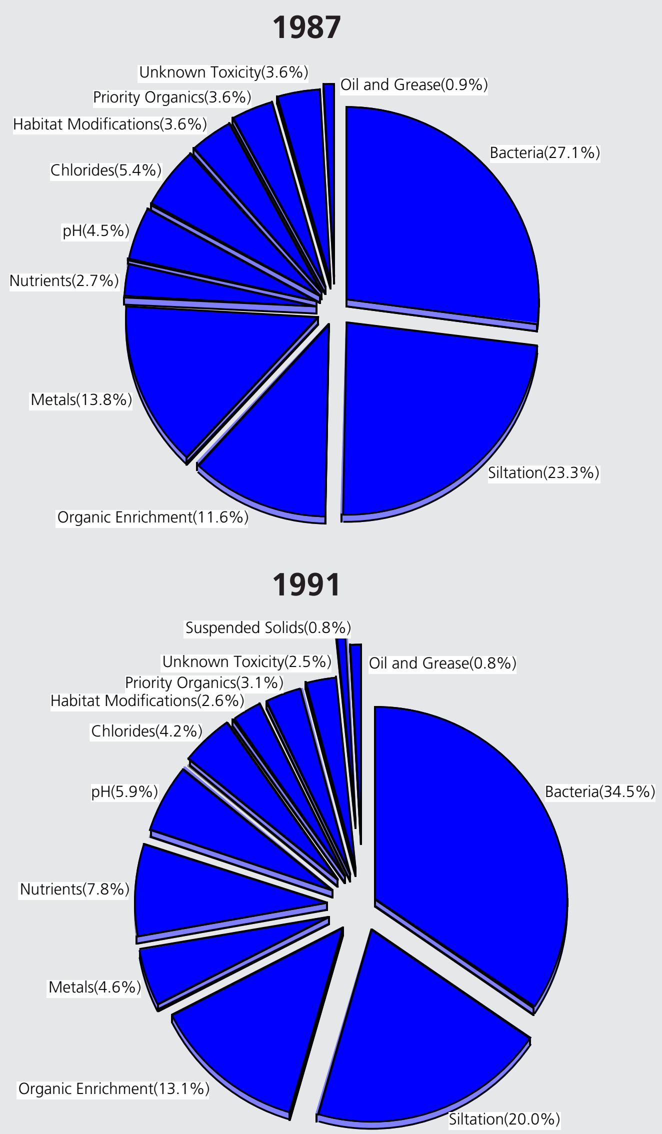
Since 1974, $534 million in federal U.S. EPA grants have been committed to improving wastewater treatment in Kentucky. These investments have assisted in reducing the percent of municipal wastewater treatment facilities in significant noncompliance with their permits, from 30% in 1982 to 15% in 1989.

Wastewater Treatment Plants Number in the Thousands; Contribute Bacteria and Other Pollutants to Streams

Although water quality improvements have been achieved from upgrading WWTPs, wastewater discharges continue to contribute much of the bacteria, nutrients, and metals polluting Kentucky streams and rivers **(Fig. 9)**. There are an estimated 3,969 municipal, industrial, and small package wastewater treatment plants operating in the state. These include 258 municipal WWTPs, 1,936 small package treatment plants, 928 industrial, 677 agricultural, 162 water plant, and 55 landfill wastewater treatment facilities. Most sewage is treated by the state's 63 major and 173 minor municipal WWTPs **(Fig. 10)**. Sewage and pollutants received at these plants are generally degraded in the treatment process or accumulated in the sludge. Some waste, however, is ultimately discharged into receiving waters as part of a plant's effluent.

Figure 9

Causes of Pollution to Rivers and Streams in Kentucky



Source: Kentucky Division of Water, 305(b) Reports, 1986–92

Bacterial contamination is the most frequently cited violation of state water quality standards. Much of this pollution is caused by improper discharges from wastewater treatment plants. There are an estimated 3,994 wastewater treatment plants operating in Kentucky.

Most sewage is treated by 63 major and 173 minor municipal wastewater treatment plants. Improperly treated wastewater discharges are a major cause of pollution problems in ten of the state's 13 river basins.

Figure 10

Kentucky Streams Impaired by Municipal Wastewater Treatment Discharges by River Basin

River Basin	Wastewater Treatment Plants: Municipal	Wastewater Treatment Plants: Small Pckg.	Miles Not Supporting Uses: 1989*	Miles Not Supporting Uses: 1991	% of Nonsupport Problem
Big Sandy	15	252	147	195	78%
Little Sandy	3	70	97	51	81%
Tygarts Creek	1	13	0	0	-
Licking	18	144	118	113	53%
Kentucky	40	309	204	146	30%
Upper Cumberland	22	190	75	52	56%
Salt	24	263	322	248	59%
Green	38	165	100	667	36%
Tradewater	4	24	0	0	-
Lower Cumberland	15	41	60	25	100%**
Tennessee	9	62	0	0	-
Mississippi	12	19	32	24	100%
Ohio & Tributaries	57	384	60	58	71%
Total	**258*****	**1,936**	**1,215**	**979**	

**Includes streams partially supporting and not supporting uses due to municipal wastewater discharges.*

***Attributed to municipal/agriculture.*

****Total includes 22 small package plants owned and operated by municipalities.*

Source: Kentucky Division of Water, 305(b) Report, 1990-92

The impact from WWTP discharges can be measured in 12 of the state's 13 river basins as seen in Figure 7. The water quality standards most often exceeded by treatment plants are fecal coliform, ammonia nitrogen, dissolved oxygen, and total suspended solids **(Fig. 11)**. Minor municipal wastewater treatment plants (plants processing less than 1 million gallons per day) are among those with the greatest percentage of water quality violations.

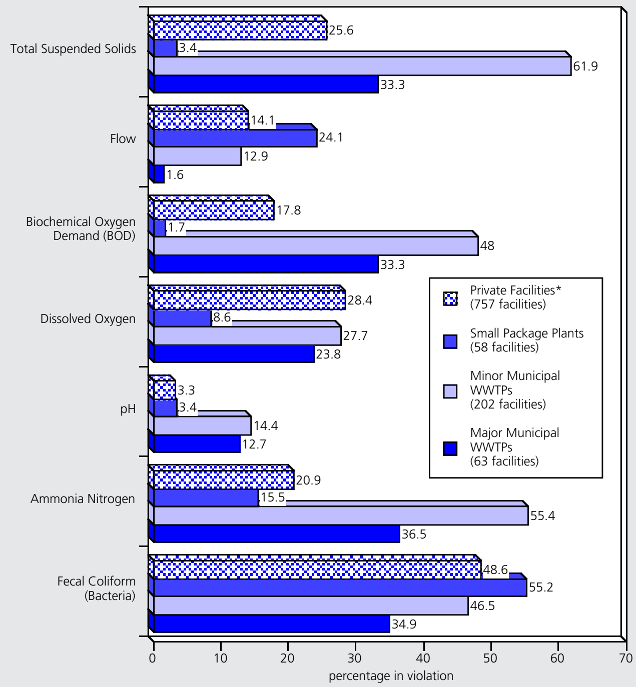
Improper releases from WWTPs were responsible for 27% of the 33 fish kill incidents reported during 1990 and 1991 **(Fig. 12)**. During these two years, there were 1,615 (409 in 1990 and 1,206 in 1991) documented reports of raw sewage that bypassed WWTPs and was discharged directly into streams. These incidents, caused by improper WWTP operation, overflows, or malfunctioning equipment, contributed to several fish kill incidents as well as pollution problems in streams and rivers.

Federal grants to upgrade WWTPs have steadily declined over the years. Faced with an estimated $1.5 billion in additional wastewater construction needs over the next 20 years (1990-2010), Kentucky established a wastewater revolving loan fund financed by $88.2 million in federal monies with a 20% state match. The $156 million revolving loan program, to be capitalized between 1988 and 1994, will help local governments address and improve their wastewater infrastructure. The U.S. EPA reports that the state's revolving loan fund program is functioning well. Between 1988 and 1991, 23 municipal wastewater projects were funded by the revolving loan program, and an additional 44 projects were in various stages of review.

The water quality standards most often exceeded by wastewater treatment plants are fecal coliform bacteria, ammonia nitrogen, and total suspended solids. Minor municipal treatment plants (plants processing less than 1 million gallons per day) are the greatest violators of water quality standards.

Figure 11

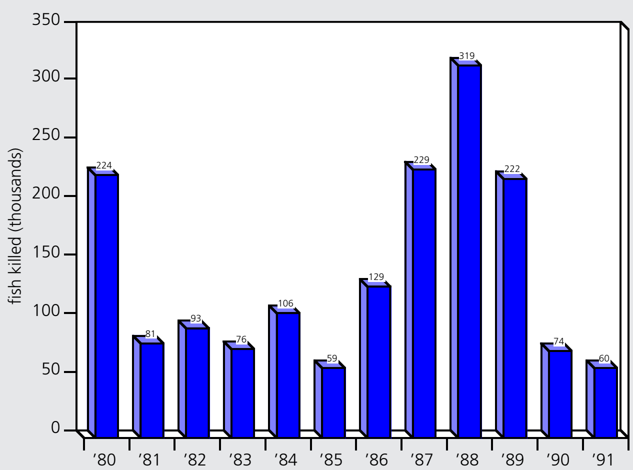
Percent of Kentucky Wastewater Treatment Facilities in Violation of Selected Water Quality Parameters (1990)



**Private wastewater facilities include school, subdivisions, and small sewage.*
Note: Based on a selective review of watsewater treatment plants (WWTPS).
Source: Kentucky Division of Water, 1991

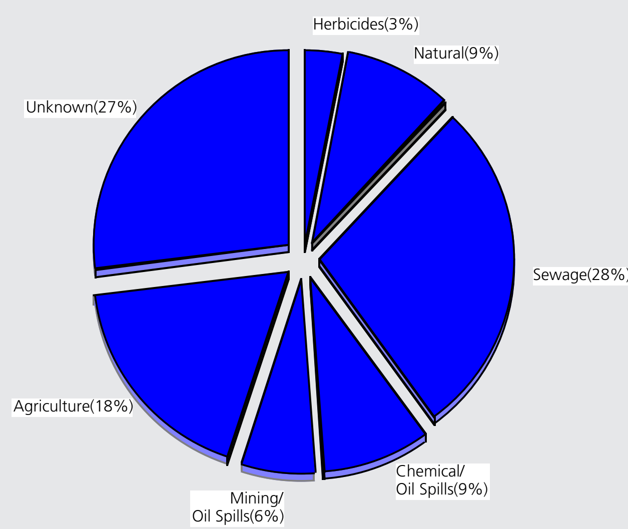
Figure 12

Fish Reported Killed by Pollution Incidents in Kentucky



Source: Kentucky Division of Water, 305(b) Report, 1992

Sources Responsible for Fish Kills



Note: Based on 33 fish kills reported in 1990-91.

Fish kills are caused by a number of pollution sources. During 1990 and 1991, improperly treated sewage caused 27% of the fish kill incidents. During that time period, there were 1,615 reports of raw sewage that bypassed treatment plants and were discharged directly into streams.

Municipal Wastewater Pretreatment Programs Help Reduce Toxic Pollutants; 21% of Industries in Significant Noncompliance with Pretreatment Requirements

In addition to domestic sewage, many municipal WWTPs receive toxic wastes from households, industries, and businesses. The U.S. EPA estimates that the average percentage of toxic pollutants received by WWTPs includes household toxics (15%), commercial businesses (15%), and industries (70%). (These estimates may differ from plant-to-plant.) Because WWTPs are generally not designed to process toxic substances, most of these chemicals simply pass through the plants and are discharged to receiving waters.

Approximately 586 Kentucky industries discharge an estimated 52 million gallons of wastewater daily into municipal WWTPs. Many of these industries discharge a significant amount of toxic constituents, such as solvents and detergents, to these plants. During 1988, 1989, and 1990, 2.8, 2.6, and 2.3 million gallons of toxics respectively, were discharged to municipal WWTPs by industries. Efforts to control industrial toxic discharges to WWTPs have been initiated in recent years. DOW requires certain industries to pretreat their wastes prior to their release to a municipal WWTP.

DOW has approved pretreatment programs at 72 municipal wastewater treatment plants **(Fig. 13)**. These programs require approximately 520 industries to pretreat their waste to remove or reduce pollutants before discharging to a municipal WWTP. Some pretreatment programs have had a significant impact in reducing pollutants, such as metals, coming into and out of treatment plants, ultimately improving water quality. In Louisville, for example, the pretreatment of wastewater by 169 industries reduced metals 84% in the effluent released by wastewater plants operated by the Louisville/Jefferson County Metropolitan Sewer District. The U.S. EPA has nationally recognized the Kentucky communities of Louisville, Corbin, Bardstown, Leitchfield, and Richmond for their pretreatment programs.

Wastewater pretreatment programs are only effective in reducing pollutants if properly implemented and enforced. DOW conducts annual audits of these programs, but routinely relies on the counties and cities to ensure proper pretreatment of wastes. In some cases, poor state and local oversight have resulted in improperly treated and discharged wastes from WWTPs. Currently, 115 industries discharging wastes to 27 municipal WWTPs are considered in significant noncompliance with their pretreatment requirements **(Fig. 14)**. The U.S. EPA has required Kentucky to establish enforcement plans to better clarify state and local roles and responsibilities for ensuring compliance with pretreatment requirements. Of the 72 pretreatment programs, 60 have completed enforcement plans.

Some municipal treatment plants process a considerable amount of industrial effluent **(Fig. 15)**. Some of these plants were designed to treat industrial wastewater, but many were not. Of the 26 municipal WWTPs with industrial flow greater than 25%, only seven were designed to totally or partially treat industrial wastewater. The other 19 plants were designed to treat household or sanitary wastewater which limits their capability to treat industrial wastewater. These plants must rely on industrial pretreatment programs in order to process wastes. However, 23% of these 26 WWTPs are currently in significant noncompliance with their pretreatment requirements.

The use of municipal WWTPs to treat industrial wastewater will continue to be a problem for many facilities that are not designed to process this waste. Many municipal facilities impose a surcharge on industrial wastewater coming into the WWTP when it contains elevated levels of pollutants. This surcharge was intended to serve as a deterrent to industries discharging concentrated wastewater. However, the average surcharge for typical pollutants is only 20 cents per pound, which may be insufficient for encouraging reduction and better pretreatment.

Figure 13

Kentucky Municipal Wastewater Plants with Pretreatment Programs

Adairville
Ashland
Auburn
Bardstown
Beaver Dam
Berea
Bowling Green
Cadiz
Calhoun
Calvert City
Campbellsville
Campbell/Kenton Co.
Caveland San. Auth.
Corbin
Cynthiana
Danville
Edmonton
Elizabethtown
Elkton
Eminence
Flemingsburg
Frankfort
Franklin
Fulton
Georgetown
Glasgow
Guthrie
Harlan
Harrodsburg
Hartford
Henderson
Hopkinsville
Jamestown–Russell Co.
Jeffersontown
Lancaster
Lawrenceburg
Lebanon
Leitchfield
Lexington
Livermore
London
Louisville
Madisonville
Marion
Mayfield
Maysville
Middlesboro
Monticello
Morganfield
Morgantown
Mount Sterling
Murray
Nicholasville
Owensboro
Owingsville
Paducah
Paris
Princeton
Richmond
Russellville
Scottsville
Shelbyville
Somerset
S. Campbell Co.
Springfield
Stanford
Tompkinsville
Versailles
Williamsburg
Williamstown
Winchester
Wurtland

Source: Kentucky Division of Water, 1992

The state has approved pretreatment programs at 72 municipal wastewater plants. These programs require approximately 520 industries to pretreat their waste before sending it to a wastewater treatment plant.

Figure 14

Industrial Pretreatment Programs in Significant Noncompliance

Municipal Wastewater Treatment Plants	Total Number of Industrial Users	Number of Users in Significant Noncompliance
Ashland STP	9	1
Auburn STP	1	1
Bowling Green STP	19	2
Calvert City STP	3	1
Campbellsville STP	7	2
Cynthiana STP	5	2
Elizabethtown STP	19	3
Eminence STP	2	1
Frankfort STP	9	1
Franklin STP	10	2
Glasgow STP	6	1
Guthrie STP	2	1
Harrodsburg STP	2	1
Hopkinsville STP	18	4
Jamestown/Russell Co.	2	1
Lawrenceburg STP	7	1
Lexington Town Br. STP	41	7
Louisville MSD	169	71
London STP	8	2
Madisonville STP	8	1
Middlesboro STP	4	1
Nicholasville STP	7	1
Paducah STP	18	2
Princeton STP	3	1
Shelbyville STP	14	1
Somerset WWTP	6	1
Winchester STP	14	2
Total 27	**413**	**115**

Note: Significant noncompliance is defined as chronic violations of discharge limits, discharges dangerous to public health, or failure to meet compliance schedules and reporting requirements.

Source: Kentucky Division of Water, 1992

Wastewater pretreatment programs are only effective in reducing toxic pollutants if properly implemented and enforced. In 1991, 21% of the industries pretreating their wastes were in significant noncompliance with their requirements.

Figure 15
Treatment of Industrial Wastes by Kentucky Municipal Wastewater Treatment Plants*

Facility	County	% industrial flow
Georgetown #2**	Scott	100
Wurtland**	Greenup	76.9
Bardstown	Nelson	68.4
Cynthiana	Harrison	64.1
Jamestown**	Russel	60.2
Louisville MSD	Jefferson Hite Creek	56.3
Adairville	Logan	51.9
South Campbell	Campbell	49.1
Calhoun**	McLean	42.2
Campbellsville	Taylor	41.2
Versailles	Woodford	40.7
Beaver Dam	Ohio	39.1
Elizabethtown	Hardin	38.4
Corbin	Laurel	36.8
Somerset	Pulaski	34.1
Fulton**	Fulton	33.5
Auburn**	Logan	32.4
Louisville MSD	Jefferson Morris Forman	29.1
Shelbyville	Shelby	27.8
Elkton	Todd	27.4
Glasgow	Barren	27.3
Springfield**	Washington	27.0
Henderson	Henderson	27.0
Tompkinsville	Monroe	26.5
Hopkinsville	Christian	25.8
Harrodsburg	Mercer	25.6

*Facilities with industrial flow greater than 25% of waste water treated.
**Municipal wastewater treatment plant designed to some degree to treat industrial waste.

Source: Kentucky Division of Water, 1992

The use of municipal waste-water treatment plants to process industrial waste is a problem for many plants. Several municipal wastewater treatment plants process a consid-erable amount of industrial waste-water. Some of these plants were designed to treat industrial effluent, but many were not.

1,936 Small Wastewater Package Treatment Plants Pose a Major Pollution Threat; Impacts to Small Streams Great

Small wastewater treatment plants, known as package plants, pose a growing threat to water quality in Kentucky. Currently, 1,936 of these plants (as seen in Figure 10) are permitted to treat domestic wastewater from small residential communities and discharge up to 10,000 gallons a day per plant. This is an increase of 356 plants since 1983. While these plants were built to protect water quality from untreated sewage discharges, improper operation and maintenance frequently occurs, resulting in pollution of many small streams into which these plants typically discharge. Many package plants are at least 20 years old, the end of a normal operating life of a plant.

Package treatment plants have become so numerous that it is difficult to inspect and monitor their operations adequately. A survey conducted by the Bluegrass Area Development District during 1990 found that 80% of the small package treatment plants in that region failed to meet permit limits during a three–month reporting period. The pollution impacts of these plants along small streams are great. In Oldham County, for example, 35 small package plants discharge thousands of gallons of wastewater daily into Harrod's Creek. The county has instituted an informal development ban along the stream because of pollution problems. DOW will also not permit additional plants on the stream. A similar ban has been issued for Floyds Fork in Jefferson County.

The need to address the cumulative impacts to streams caused by improperly functioning small wastewater package plants and better plan to avoid these problems is urgent. The Bluegrass, Purchase and Big Sandy Area Development Districts, the Gateway District Health Department, and the Council of State Governments, through a cooperative arrangement with DOW and the U.S. EPA, conducted an inventory of existing package plants and identified options to consolidate wastewater plants. According to DOW, this initiative resulted in the following:

- elimination of a number of existing package treatment plants;
- prevention of package treatment plant construction by connection to municipal systems;
- inclusion of siting restrictions on package plants in local land use plans; and
- takeover of some plants by a responsible entity.

The expansion of these efforts statewide would greatly assist in addressing as well as preventing pollution problems caused by these plants.

227 Sewer/ Stormwater Discharge Points in 21 Cities Impact Streams

Some municipal WWTPs experience problems from high flows during storms, particularly in older cities where stormwater runoff is likely to be carried in sanitary sewer pipes. DOW estimates there are 227 combined sewer/stormwater overflow discharge points located in 21 older cities **(Fig. 16)**. These older systems carry large amounts of stormwater to municipal WWTPs during wet weather, forcing sewers to overflow and discharge raw sewage into receiving waters. In 1991, combined sewer/stormwater overflows contributed to the degradation of 56 miles of the Licking River and 443 miles of the Ohio River. The U.S. EPA recently approved a state strategy to bring these discharges into compliance with water quality standards. Swift implementation of this strategy may assist in minimizing stream pollution impacts from combined sewer overflows.

Figure 16
Kentucky Cities with Combined Sewer Overflows

City	Number of Overflow Points	City	Number of Overflow Points
Ashland	8	Maysville	2
Butler	1	Morganfield	3
Campbell/Kenton S. D. #1	6	Morris Forman MSD	121
Campbellsburg	1	Owensboro	5
Carrollton	3	Paducah	14
Catlettsburg	13	Pikeville	2
Elkhorn City	1	Prestonsburg	3
Frankfort	15	Princeton	2
Harlan	4	Vanceburg	3
Henderson	14	Worthington	3
Lebanon	3		

Source: Kentucky Division of Water, 1992

Combined sewer overflows occur in older cities where stormwater runoff is likely to be carried in sanitary sewer pipes. During wet weather, these systems overflow and discharge raw sewage into receiving waters. A state strategy to address these discharges was recently approved by the U.S. EPA.

Industrial Discharges Cause 3% of Water Pollution; Toxics a Growing Concern

Discharges from industries are currently impacting 3% of the streams impaired by pollution. These discharges affect six of Kentucky's 13 river basins. This is a significant decline since 1982 when industrial discharges caused pollution in 25% of the streams assessed. Currently, DOW permits water discharges at 928 industrial facilities. In 1991, 12% of these facilities were not complying with their permits, and 5% were in significant noncompliance.

Over the years, industries have been fairly successful in controlling conventional pollutants in their water discharges. Toxic discharges, however, have become a growing threat to waterways. As additional monitoring requirements take effect, more instances of toxic contamination are discovered. Data provided by manufacturing industries revealed that during 1988, 1989, and 1990, these facilities discharged 1.7 million, 791,000, and 736,700 pounds of toxic substances, respectively, into Kentucky streams **(Fig. 17)**.

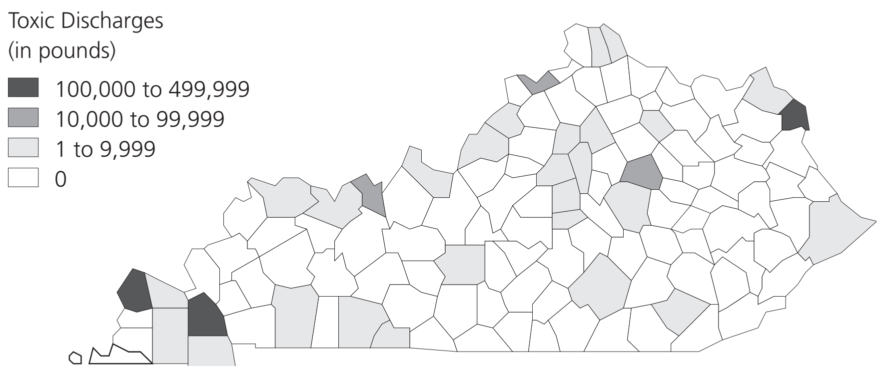
Since it is not economically feasible to determine the toxicity of each of the thousands of potentially toxic substances in water discharges, the state relies on toxicity testing to determine water quality impacts. Toxicity tests were performed by DOW at 54 municipal and industrial wastewater facilities during 1988 and 1989. The testing detected acute toxicity at 34 locations directly impacting 174 miles of streams in eight river basins.

The permits of many industrial and municipal facilities are currently being revised to improve the control of toxic substances in their discharges through biomonitoring. Biomonitoring, also called whole effluent toxicity testing, uses living organisms to test the suitability of effluents released into receiving waters to aquatic life. DOW currently requires biomonitoring at 35 industrial and 77 municipal wastewater treatment plants.

A DOW assessment of 1991 data from facilities with biomonitoring revealed that in 48% of the tests performed on municipal effluent and 43% of the tests performed on industrial effluent, the wastewater failed to meet toxicity requirements. Two consecutive failures to meet toxicity requirements results in a facility entering a "toxicity reduction evaluation." Thirty-five percent of facilities with biomonitoring (28 municipal and 11 industrial) are in the process of conducting a toxicity reduction evaluation to assess and minimize toxic discharges.

Toxic contamination has also led to the posting of four fish consumption advisories along the Ohio River, Town Branch of the Mud River, Drakes Creek, and Little Bayou Creek **(Fig. 18)**.

Figure 17
Industrial Toxic Discharges into Streams (1990)



Source: Kentucky Department for Environmental Protection, Toxic Chemical Release Inventory Data, 1990

Toxic discharges have become a growing concern in streams across the state. Between 1988 and 1990, industries reported discharging 3.2 million pounds of toxic substances into Kentucky's streams. Another 7.7 million pounds were transferred to municipal wastewater treatment plants and discharged into streams.

Figure 18
Fish Consumption Advisories in Effect in Kentucky

Stream/County	Pollutants	Source	Miles Covered	Date Established	Status
Town Branch/Mud River Logan/Butler/Muhlenburg	PCBs	Dye–casting plant plant	64.7	Oct. 1985	Cleanup in progress; monitoring continues.
West Fork Drakes Creek Simpson/Warren	PCBs	Adhesive plant plant	46.8	April 1985	Monitoring continues; levels in fish appear to be declining.
Little Bayou Creek McCracken	PCBs	Gaseous diffusion plant	5.0	April 1989	On–site cleanup in progress; monitoring continues; contamination appears limited to Little Bayou Creek.
Ohio River/ Entire length	PCBs Chlordane	Urban runoff	664	June 1989	Catfish and white bass listed; monitoring continues; revised in 1990 to cover entire length of the Ohio River bordering Kentucky.

Source: Kentucky Division of Water, 1991

Toxic contamination has led to the posting of four fish consumption advisories in Kentucky. Tests also revealed that 35% of the 112 municipal and industrial facilities monitoring discharges for toxicity in 1991 failed to meet requirements and must perform evaluations to assess and reduce toxic discharges.

Toxic Spills Account for 78% of State Emergencies; Reported Incidents Increase From One to Six a Day

Spills of hazardous and toxic pollutants are also impacting streams and rivers. Each year, millions of gallons of chemicals, fuels, and hazardous and toxic substances are accidentally spilled along transportation routes and at industrial facilities. Almost 78% of the 1,777 emergencies responded to by state Disaster and Emergency Services (DES) personnel in 1990 involved hazardous or toxic spills. And many more spills go unreported, according to DES officials.

Incident notifications received by the Kentucky Department for Environmental Protection's Environmental Response Team (ERT) have increased from one report a day in 1983 to six per day in 1991. While this is likely due to additional reporting requirements instituted in 1987, it may also reflect the steady increase in the production and handling of the 70,000 individual chemicals commercially marketed in the U.S., as well as an increase in truck transportation along major highways. During 1991, 2,061 incidents were reported to ERT and 584 (28%) required emergency response.

Toxic spills in the Ohio River have nearly doubled since 1989. During 1990 and 1991, 238 spills were reported and 23 public water supply intakes had to be temporarily closed due to these incidents. Efforts to assure facilities handling toxic chemicals have adequate spill response plans, promote greater local/state coordination when reporting and responding to spills, refine and improve county emergency response plans, and improve spill reporting requirements are needed if Kentucky is to minimize the environmental and public health impacts caused by these incidents.

Resource Extraction Impacts 1,058 Miles of Streams; More Attention to Assessing Problems Critically Needed

Pollutants from coal mines, petroleum operations, and other resource extraction activities are known to have impacted at least 1,058 miles of Kentucky streams during 1991, 1,006 miles of which were considered severely damaged. Resource extraction activities contribute 19% of the pollution problems in streams and rivers in Kentucky.

Discharges from surface and underground coal mining continue to cause major pollution problems in six of the state's 13 river basins **(Fig. 19)**. The state assumed authority from the federal government in 1982 to regulate coal mining in Kentucky. Coal mine water discharges are regulated through general KPDES water discharge permits. There are water discharge permits currently in effect for 4,100 coal mine operations and related activities. The enforcement of these permits is carried out by the Kentucky Department for Surface Mining Reclamation and Enforcement (DSMRE). Coordination between DOW and DSMRE to monitor compliance with these permits has been limited, although efforts are ongoing to improve communication and enforcement efforts. A further discussion of water quality issues associated with mining can be found in the Coal Mining Chapter of this report.

Figure 19
Kentucky Streams Impacted by Coal Mining Activities

River Basin	Miles not supporting uses 1989*	1991	% Nonsupport Problem
Big Sandy	172	30	12%
Little Sandy	31	0	-
Kentucky	104	82	17%
Green	103	68	36%
Upper Cumberland	167	40	43%
Tradewater	209	91	100%**
Total	**786**	**317**	

**Includes streams partially supporting and not supporting uses.*
***Attributed to mining/agriculture.*
Note: Data for Ohio River reveals 817 miles are impacted by mining activities.
Source: Kentucky Division of Water, 305(b) Report, 1990-1992

Coal mining is responsible for pollution impacting 317 miles of streams and rivers in Kentucky. It is a major/moderate cause of nonsupport in six of the state's river basins.

Salty Brines Produced by Oil and Gas Well Drilling Continue to Impact Streams

Oil and gas production continues to pollute streams with salty brines removed during drilling operations. Brines, which can contain more salt than is found in sea water, currently impact water quality in six of the state's 13 river basins. Several streams have been extensively degraded by oil and gas operations. Brine discharges to streams in the Kentucky River Basin have eliminated aquatic life in some areas and contaminated downstream public water supplies. To control the impact of oil and gas brine discharges, the state established a chloride standard of 600 milligrams per liter in 1985.

There are approximately 20,000 oil and 10,000 natural gas wells operating in Kentucky. Since 1985, KPDES permits to control brine discharges have been issued for an estimated 900 operations. Another 600 operations are permitted by the U.S. EPA to reinject their oil field brines deep into the earth through injection wells. The large number of oil and gas operations, however, makes the enforcement of the chloride standard difficult. Chloride levels have increased in 11 of the 14 streams with continuous monitors, according to 1989 trend reports. Only one stream showed a decrease in chloride levels during this time **(Fig. 20)**.

While water quality trends were not fully assessed by DOW in 1990 and 1991, a review of three stations in the Kentucky River revealed a decreasing trend in chloride levels during this time. In addition, water quality improvements in the Right and Left forks of Blaine Creek in Lawrence County and the Big Sandy and Licking rivers indicate that enforcement of the chloride standard may be accomplishing results.

Oil and gas production and other industrial processes continue to pollute streams with chlorides. A state chloride standard was adopted in 1985, however, with more than 30,000 active oil and gas wells in operation, enforcement of the standard has been difficult. Some water quality improvements for chlorides have been seen in the Kentucky, Big Sandy, and Licking river basins during 1990 and 1991.

Figure 20

Kentucky Streams Impaired by Chloride Pollution

River Basin	Miles not supporting use 1987*	1989*	1991	% Nonsupport Problem
Licking River	13	36	37	17%
Kentucky River	60	83	44	9%
Big Sandy	66	34	0	-
Little Sandy	31	12	12	19%
Green River	0	52	18	9%
Upper Cumberland	21	59	3	3%
Total	**191**	**276**	**114**	

Streams with Increasing Chloride Levels (1989)

Basin	Tributaries and Counties
Big Sandy	Levisa Fork at Pikeville, Pike Co.
Little Sandy	Levisa Fork at Paintsville, Johnson Co.
	Tygarts Creed at Load, Greenup Co.
Kentucky River	North Fork at Jackson, Breathitt Co.
	South Fork at Booneville, Owsley Co.**
	Kentucky River at Heidelberg, Lee Co.**
	Eagle Creek at Glencoe, Gallatin Co.
Green River	Nolin River at White Mill, Hardin Co.
	Mud River at Lewisburg, Logan Co.
	Rough River at Dundee, Ohio Co.
Tradewater	Tradewater at Olney, Hopkins Co.

**includes streams partially supporting and not supporting uses*
***1990-91 data show that chloride levels are decreasing.*
Source: Kentucky Division of Water, 305(b) Reports, 1988-1992

Continuing these positive trends will require continued state enforcement of the chloride standard as well as ensuring that oil and gas operations are properly permitted. The Department of Mines and Minerals (DMM) is the state agency that permits oil and gas operations. DMM has only 13 inspectors to monitor the compliance of the 30,000 oil and gas wells currently in production. An additional state commitment of resources is needed to ensure that these operations are permitted and that wells are properly plugged to prevent groundwater pollution.

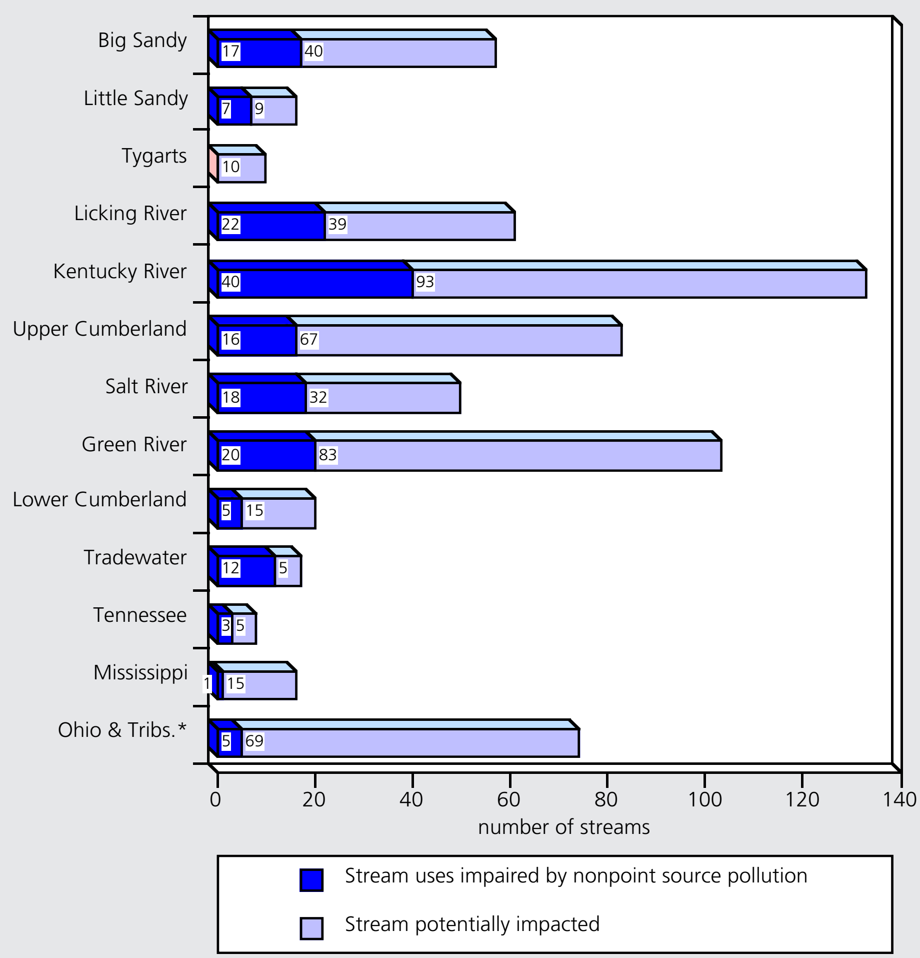
Nonpoint Source Runoff Pollution in Streams and Rivers

Runoff Pollution Impacting More than 60% of Streams and Rivers Affected by Pollution

Runoff from farming, mining, forestry, construction, and urban activities, known as nonpoint source pollution, is the primary reason why 62% of the state's impaired streams and rivers cannot be fully used for fishing, swimming, or water supply **(Fig. 21)**. The federal Water Quality Act of 1987 specifically required Kentucky and other states to identify and assess waters impaired by runoff pollution and develop programs to address these problems. In response, DOW prepared the 1988 Nonpoint Source Assessment report. The report has since been updated, identifying 648 streams, 95 wetlands, and 61 groundwater basins that have been, or may potentially be, impacted by runoff pollution.

The list of impacted waters is based on water quality monitoring and biological data, investigative assessments, and information obtained from a 1987 survey of Kentucky Soil Conservation Districts. It is difficult to assess water quality trends in the area of nonpoint source runoff pollution since data is limited and nonpoint source indicators are not consistently available. It is apparent, however, that nonpoint source runoff pollution is a major threat to the quality of the state's rivers and streams and will require additional attention if progress is to be made.

Figure 21
Streams in Kentucky Impacted by Nonpoint Source Runoff Pollution



Source: Kentucky Division of Water, 305(b) Report, 1992

Runoff from farming, mining, logging, construction, and other land disturbing activities, known as nonpoint source pollution, is the reason why more than 60% of the state's impaired streams cannot meet their designated uses. An estimated 648 streams have been, or are, threatened by runoff pollution.

Runoff Pollution From Farms a Major Problem in Eight River Basins

Nonpoint source runoff from agricultural activities impacts 30% of the streams and rivers impaired by pollution as seen in Figures 6 and 7. It is considered a major problem in eight of the state's 13 river basins **(Fig. 22)**.

Kentucky faces a significant challenge in minimizing runoff pollution from agriculture activities. Rainwater washing over farmlands carries topsoil, animal wastes, and chemical residues into nearby streams, contributing sediment, nitrates, phosphorus, pesticides, bacteria, and other pollutants. State efforts to control soil erosion on cropland include retiring 400,000 acres of highly erodible farmland under the National Conservation Reserve Program.

In 1987, three million acres of Kentucky cropland and 669,500 acres of pastureland were still in need of conservation measures to prevent erosion, according to the U.S. Soil Conservation Service. The promotion of farmland erosion control practices has helped to reduce average soil erosion rates in the state from 8.92 tons/acre/year in 1987, to 8.51 tons/acre/year in 1989. However, farmland erosion rates in Kentucky are still well above the national average of 5 tons/acre/year.

Cropland planting practices which cause less soil disturbance, such as no–till, have reduced erosion problems on over 2.5 million acres of Kentucky farmland, ranking the state first in the nation for promoting farmland conservation practices. These techniques may, however, increase the amount of chemicals used to control weeds. During 1990, Kentucky farmers and other certified commercial applicators used 9 million pounds of active pesticide ingredients, compared to an estimated 2.1 million in 1979. Kentucky is ranked 20th in the nation for the use of agricultural pesticides, according to the U.S. EPA's National Pesticide Usage Database.

The extent of surface water contamination from pesticide runoff is not well known. DOW has cited pesticides as a nonpoint source pollution threat in Triplett Creek in Rowan County, the South Fork of the Licking River, and Strodes Creek in Bourbon County. Controlling nonpoint source pollution from agricultural activities in Kentucky is being pursued through education and the voluntary use of conservation practices and is discussed in more detail in the Natural Resources Chapter of this report.

Figure 22

Kentucky Streams Impacted by Agriculture Activities

River Basin	Miles not Supporting Uses 1989*	Miles not Supporting Uses 1991	% Nonsupport Problem
Big Sandy	153.7	194.4	78%
Little Sandy	82.2	39.3	63%
Licking	167.8	153.4	71%
Kentucky	152.2	52.9	11%
Salt	48.3	244.7	58%
Green	181.3	63.4	34%
Lower Cumberland	128.5	25.1	100%**
Tradewater	209.8	91.1	100%***
Tennessee	21.5	—	—
Mississippi	31.8	—	—
Ohio Tributaries	35.3	—	—
Total	**1,212.4**	**864.3**	

**Includes streams partially supporting and not supporting uses.*

***Attributed to agriculture/municipal*

****Attributed to agriculture/mining.*

Note: 1,302 miles of the Ohio River are impacted by agricultural activities.

Source: Kentucky Division of Water, 305(b) Report, 1990-1992

Nonpoint source runoff from agricultural activities impacts 30% of the streams and rivers impaired by pollution. It is considered a major problem in eight river basins.

Acid Mine Runoff Impacting Five River Basins; Full Extent Unknown

Runoff pollution from 90,000 acres of abandoned mine lands as well as improperly operated and reclaimed mine sites contributes 6% of the water quality problems in Kentucky. DOW indicates that 175 stream segments, 51 wetlands, and seven public lakes are impacted or potentially affected by coal mine runoff pollution.

The impacts from acid mine drainage have not been extensively assessed since 1981. At that time, more than 1,000 stream miles were significantly affected by acid mine drainage in seven river basins **(Fig. 23)**. Presently, 244 stream miles in five river basins are impacted by acid mine drainage, according to stream monitoring reports. The greatest impacts are occurring in the Green, Tradewater, and Upper Cumberland river basins. More attention to monitoring and assessing the impacts of coal mining and other mineral extraction activities on water quality is critical if the state is to make progress in restoring its rivers and streams.

Figure 23

Streams in Kentucky Impacted by Acid Mine Drainage

River Basin	Miles not supporting uses				% Nonsupport
	1981*	1985*	1989*	1991	Problem
Big Sandy	142.8	n/a	5.3	9.5	3%
Little Sandy	31.1	n/a	0	0	-
Kentucky River	138.0	n/a	0	8.5	2%
Upper Cumberland	167.1	n/a	17.3	37.9	40%
Green River	103.7	n/a	156.3	97.6	52%
Tradewater River	209.8	n/a	113.1	91.1	100%***
Ohio River**	214.3	n/a	n/a	n/a	-
Total	**1006.8**	**357**	**296.2**	**244.1**	

**Includes streams partially supporting and not supporting uses.*

***Mineral extraction/oil and gas.*

**** Mining/agriculture impacts combined.*

n/a - Not available

Source: Kentuky Division of Water 305(b) Reports, 1982-1992

Acid mine drainage from coal mines is a problem in several streams, but has not been extensively assessed since 1981.

Runoff Pollution from Urban Areas to be Controlled Under New Federal Stormwater Programs

Kentucky waterways are also impacted by a number of other pollutants produced by urban runoff, open dumps, and septic tanks. These sources of water pollution have received increased attention from both the state and federal government during the past few years.

Urban runoff from streets, parking lots, and storm sewers causes water pollution problems particularly when it is discharged into receiving waters in large amounts. Urban runoff can carry substances such as oil and grease, arsenic, solid wastes, gasoline, and a range of other pollutants. These pollutants currently impact water quality in seven river basins and were responsible for the degradation of 238 miles of streams in 1987, 260 in 1989, and 398 stream miles in 1991. Tributaries draining the urbanized areas of Covington, Newport, Fort Thomas, Louisville, Paducah, Benton, Murray, and Lexington are of primary concern. Urban runoff is suspected of causing the fish consumption advisory in effect along the Ohio River. State permits to control stormwater discharges have been required for the past five years. However, regulations promulgated by the U.S. EPA in November 1990, expand the number of operations that must be covered by these permits.

The federal permitting program targets the water quality impacts resulting from urban and industrial stormwater runoff. Four groups are affected by the U.S. EPA regulations:

- Large and medium–size cities with populations of more than 100,000;
- Certain industrial categories, such as manufacturing and maintenance;
- Industrial activities of governmental bodies, including vehicle maintenance shops, landfills, and sewage treatment plants with flows of one million gallons a day; and
- Construction sites of five acres or more. (Runoff from agriculture, mining, and oil and gas are excluded.)

The U.S. EPA's permit requirements are expected to be finalized in 1992. To meet the federal regulations, Kentucky will develop a general permit for stormwater discharges. Some facilities, however, may require individual permits. Federal regulations to control stormwater runoff from facilities that handle toxic chemicals are expected in the near future.

5,000 Open Dumps and Improper On-site Sewage Disposal Impacting Rivers and Streams

Runoff pollution from land disposal practices and septic tanks are impacting water quality in nine river basins in Kentucky.

An estimated 270,000 to 410,000 tons of garbage are improperly dumped every year in Kentucky. Much of this trash is washed into rivers and streams causing water pollution as well as aesthetic impacts. State and local efforts to promote universal collection of garbage should assist in discouraging dumping. However, the investigation and cleanup of some 5,000 open dumps and 626 inactive solid waste landfills and landfarming operations is a major state and local challenge. A greater commitment of resources is needed to identify, assess, and clean up waste dumps in Kentucky.

More than half a million septic tanks, now referred to as on–site sewage disposal systems, are scattered across the Commonwealth. To better control bacterial pollution from these systems, the state adopted regulations in 1985 to ensure their proper installation and operation. Since then, the Kentucky Department for Health Services has issued an average of 8,000 on–site sewage disposal permits a year.

But older septic tanks and improperly maintained systems continue to pose a threat to water resources. In 1988, local health departments investigated 3,077 complaints of surfacing sewage. In 1989, those complaints nearly doubled to 5,733. In addition, the legislature exempted farmsteads of ten acres or more from the on–site sewage disposal rules in 1986. Since then, an estimated 3,000 to 4,000 farmsteads have received exemptions to the state rules each year. It is not known just how many farmsteads are discharging household sewage directly into waterways, but these discharges are very likely contributing to the increase in bacterial contamination of streams and rivers across the state. Legislation repealing this exemption passed in the 1992 Kentucky legislative session which should greatly assist in improving water quality in streams and rivers, although existing exemptions were grandfathered in.

Domestic sewage seepage pits also pose major water pollution problems. Seepage pits are little more than raw sewage injection wells. While construction of new seepage pits for home use was banned in 1985, existing pits and their continued construction in certain areas of the state is a problem. For example, an estimated 15,000 seepage pits have been installed at residential developments in Jefferson County since 1985. Stronger enforcement of state on–site sewage disposal laws and regulations would have a significant effect in protecting water resources in Kentucky.

17 Counties Enact Ordinances to Control Runoff Pollution from Construction Sites

Nonpoint source runoff pollution is also caused by construction and road building activities. The extent to which these activities impact water quality is difficult to determine. DOW, however, indicates that construction activities are currently affecting seven river basins. Runoff from forestry activities, including logging and road building, contribute pollution problems in ten river basins.

In an effort to reduce runoff, some communities have enacted local erosion control ordinances, regulations, and agreements. Presently, 17 counties have various measures in place to address erosion problems at housing and industrial development sites. They include: Anderson, Boone, Christian, Fayette, Franklin, Grant, Henderson, Hopkins, Jefferson, Kenton, Madison, McCreary, Oldham, Simpson, Union, Warren, and Wayne counties. Most measures require building permit applicants to have an approved erosion control plan. City or county officials inspect the site and have authority to revoke the permit when erosion plans are not followed.

Nonpoint source runoff pollution is a major issue that will require additional state attention if progress is to be made. In the past, this problem has been treated through voluntary measures. However, pressure to regulate runoff pollution is increasing. Kentucky must develop viable options to combat this problem in a more effective manner. This may include the development of cooperative state/local watershed protection strategies, a strong statewide education and information program, and financial incentives, as well as disincentives, to preserve stream corridors.

Stream Modification

Alteration and Modification of Streams Impact Water Quality; Monitoring Compliance with Dredge and Fill Permits Weak

Water quality and aquatic habitat in Kentucky have been significantly impacted by stream channelization and other modifications. Stream modification can occur during many land use activities such as road construction, navigation dredging, surface mining, and various development projects. The full extent of stream modification is not known, but it contributed to the degradation of at least 179 miles of streams in Kentucky during 1991, 168 of which were severely impacted.

The U.S. Army Corps of Engineers (COE) issues dredge and fill permits for some activities that result in stream or wetland modification. Between December 1990 and March 1992, 83 individual dredge and fill permits were issued by the U.S. COE in Kentucky. Most of these were for modifications along the Ohio River.

The Kentucky Division of Water reviews these permits to minimize adverse impacts to water quality and aquatic habitat. Through the issuance of water quality certifications, the Division can require remedial efforts to offset the impacts of these modifications. Such measures may include stabilizing stream banks and restoring other natural qualities to enhance habitat for aquatic life. DOW issued 61 water quality certifications for individual dredge and fill activities between December 1990 and March 1992.

Modifications of small, low flow streams are automatically permitted through general permits issued by the U.S. COE. Hundreds of small streams have been modified or altered in Kentucky, but the full impact of this activity is generally unknown in the state. DOW recently began reviewing and certifying activities occurring under the U.S. COE general permits when they impact 200 feet or more of these small streams. In an attempt to minimize or mitigate impacts, DOW often specifies certain conditions be maintained. Between January 1991, and March 1992, DOW issued 83 such certifications.

Perhaps the weakest aspect of both the U.S. COE and DOW programs is the lack of monitoring compliance with the conditions of the respective permits. Neither agency has the necessary resources or staff for an effective compliance/enforcement program. Most stream modification activities are not visited after permit issuance and the overall impacts are unknown.

Soil Mining Along Streams and In Channels Unregulated in Kentucky

Soil mining in streams for coal, topsoil, sand, and gravel is another stream modification activity that has not been adequately addressed in Kentucky. These activities are generally unregulated in stream channels. Dredge and fill permits are not required. The federal Office of Surface Mining has taken the position that removing coal by dredging is not mining and is, therefore, exempt from mining regulations. The Kentucky Division of Water has been able to address dredging for coal somewhat, which has been extensive in the Big Sandy River, by classifying the sand that is removed during mining as a waste that cannot be reintroduced into the stream without being treated. However, DOW has no clear authority to control stream mining in areas such as sand and gravel bars.

The Floyds Fork area of Jefferson County has been the focus of local efforts to address soil mining and other issues involving water resources and development. The county is currently considering an ordinance that would require buffer zones to be maintained in riparian areas. The state, however, needs to assess the problem of stream modification and channelization more fully and develop a strategy to minimize water quality and use impacts.

Lakes and Reservoirs

The Commonwealth has some of the most beautiful lakes in the nation. The 159 publicly–owned lakes and 19 major reservoirs serve as both primary and secondary sources of drinking water and contribute to the state’s $4.3 billion a year tourism industry. An estimated 60,000 to 75,000 private lakes larger than one–quarter acre also provide local water supplies, fishing, and recreational opportunities.

Premature Aging of Lakes Steadily Increasing; Sedimentation and Nutrients Major Cause

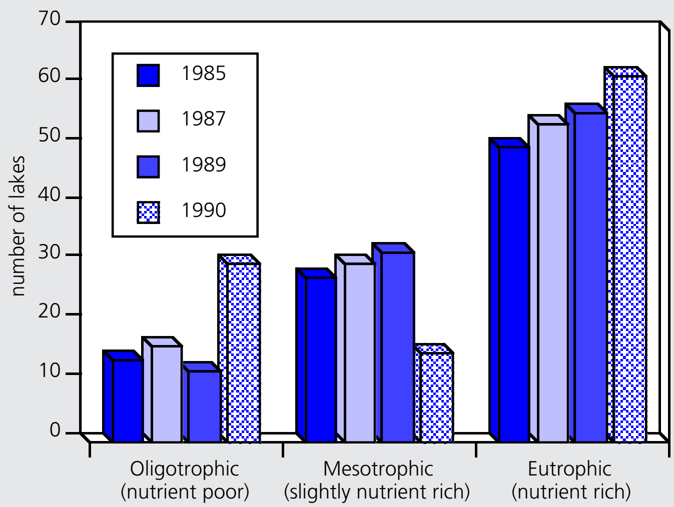
Lakes change over time, accumulating nutrients and silt, eventually evolving from lakes to wetlands, and then to dry land. This natural process, called eutrophication, normally takes hundreds of years. But human activities have accelerated the process at a number of lakes in the state. “Cultural eutrophication,” used to describe these human effects, is steadily increasing. It currently impacts more than half of the 102 publicly–owned lakes assessed **(Fig. 24)**. The symptoms of premature aging in lakes are easily recognized: masses of plants, green scum on the water surface, reduced lake depths, dead or diseased fish, and taste, odor, and other drinking water treatment problems. These symptoms don’t necessarily signal the death of a lake, but they do call for analysis and treatment.

38% of 102 Lakes Assessed are Degraded; Wastewater Treatment Plants and Industrial Discharges Impact 23%

About 38% of the 102 lakes assessed are not fully meeting their designated uses **(Fig. 25)**. In 1991, five lakes were added to the list of 35 that did not fully support their uses. Two lakes - Williamstown in Grant County and Kingfisher in Daviess County - were delisted and are now considered to fully support their uses.

Major sources of lake pollution reflect the same general trends identified for streams and rivers. Industrial and municipal discharges affect 23% of the lakes impacted, and nonpoint source runoff pollution causes 54% of the problems **(Fig. 26)**. Nutrients, primarily phosphorus, are the principal reason why many lakes cannot be fully used for fishing, swimming, or water supply **(Fig. 27)**. In excess amounts, phosphorus can cause a proliferation of algae growth. Algae creates taste and odor problems in lake water used as a source for drinking water. Dissolved oxygen can also be lowered in surface water by very productive algal populations. This may result in fish kills, or low oxygen levels incapable of supporting healthy populations of fish.

Figure 24
Premature Aging of Lakes in Kentucky



Source: Kentucky Division of Water, 305(b) Reports, 1984-1992

The natural lake aging process takes hundreds of years. But human activities have sped this process. "Cultural eutrophication," used to describe these human effects, causes over half of the 102 public lakes monitored in Kentucky to prematurely age, resulting in a variety of problems including green scum, dead fish, and reduced lake depths.

Phosphorus is present in municipal wastewater discharges and is considered a source of pollution when discharged to lakes. Wastewater plant discharges into lake tributaries are responsible for the degradation at three of the seven lakes significantly impacted by pollution. Currently, the state permits 107 KPDES water discharges to lakes. These permits are issued to three municipal wastewater treatment plants, seven industrial facilities, and 97 others, most of which are small package wastewater treatment plants.

Whether public lakes should be used as discharge points for pollutants is a continuing debate in Kentucky. The DOW's recent decision to allow the Russell County Regional Sewage Treatment Plant in Jamestown to build a 7.45–mile discharge pipeline to Lake Cumberland has been challenged by environmental and sports groups. The permit would allow wastewater discharges to Lake Cumberland in excess of acute water quality criteria, through the use of a "zone of initial dilution" (ZID). This is the first permit to allow a ZID to be used in a lake. The ZID provision has been incorporated into approximately 20 other KPDES permits to allow the discharge of elevated levels of pollutants to Big Sandy, Rough, Licking, Ohio, Tennessee, and Little Sandy rivers. State legislation to restrict the use of ZIDs in major recreational lakes was sponsored in the 1992 General Assembly, but stalled in Committee.

Nonpoint Source Runoff Responsible for 54% of Pollution at Lakes; Protection and Restoration Efforts Needed

Nonpoint source runoff pollution affects 54% of the lakes that cannot meet their designated uses. This includes farmland soil erosion and runoff from livestock holding areas which contribute 28% of the problem and impact five of the nine lakes which are significantly affected by nonpoint source runoff pollution.

Runoff from coal mining activities is the next greatest contributor to nonpoint source pollution in lakes. For example, acid drainage from abandoned mine lands in Hopkins County is impacting the domestic water supply provided by Loch Mary Lake causing taste and odor complaints, and has increased treatment costs due to excessive hardness and manganese. Coal mining activities are also impacting recreational uses and fishing in Dewey, Fishtrap, Buckhorn, Carr Fork, Crank's Creek, and Martins Fork lakes. These lakes became turbid after receiving runoff laden with sediment or were impacted by acid mine drainage from lands disturbed by coal mining activities.

Figure 25
Impaired Public Lakes in Kentucky

Basin	Lake	County	Listed	Cause	Source	Impact
Big Sandy	Fishtrap	Pike	1980	Suspended solids	Mining	Recreation
	Dewey	Floyd	1980	Suspended solids	Mining	Recreation
Licking	Kincaid	Pendleton	1983	Nutrients	Unknown	Aquatic habitat
	Sand Lick Creek	Fleming	1989	Nutrients	Agriculture	Aquatic habitat
Upper Cumberland	Corbin*	Laurel	1983	Nutrients	Municipal, Agriculture	Water supply
	Cranks Creek	Harlan	1989	pH	Mining	Aquatic habitat/rec
	Laurel Creek	McCreary	1983	Nutrients	Natural	Water supply
	Laurel River (headwaters)	Laurel	1980	Nutrients	Municipal, Agriculture	Recreation
	Martins Fork	Harlan	1980	Suspended solids	Mining	Recreation
Salt	Guist Creek	Shelby	1983	Nutrients	Agriculture	Recreation/aq.habitat
	McNeely*	Jefferson	1980	Nutrients	Municipal, Sediment	Aquatic habitat
	Shelby	Shelby	1983	Nutrients	Agriculture	Aquatic habitat
	Taylorsville*	Spencer/Anderson	1985	Nutrients	Municipal, Agriculture	Aquatic habitat
	Marion County	Marion	1983	Nutrients	Lake fertilization	Recreation
	Sympson*	Nelson	1980	Nutrients	Agriculture	Water supply
Green	Campbellsville	Taylor	1983	Nutrients	Agriculture	Aquatic habitat
	Metcalfe County	Metcalfe	1983	Shallow basin	Natural	Recreation
	Salem	Larue	1983	Shallow basin	Natural	Recreation
	Spa	Logan	1989	Nutrients	Agriculture	Aquatic habitat
	Caneyville	Grayson	1983	Nutrients	Natural	Water supply/rec.
	Rough River	Breckinridge/Grayson	1983	Metals	Natural	Water supply
	Liberty	Casey	1983	Metals	Natural	Water supply
	Briggs**	Logan	1983	Nutrients	Lake fertilization	Recreation
	Washburn	Ohio	1991	Nutrients	Unknown	Aquatic habitat
Tradewater	Loch Mary*	Hopkins	1980	Metals	Mining	Water supply
	Beshear	Caldwell/Christian	1991	Nutrients	Natural	Aquatic habitat
Lower Cumberland	Honker	Trigg	1989	Nutrients	Natural	Aquatic habitat
	Morris	Christian	1983	Nutrients	Natural	Water supply
Kentucky	Herrington**	Boyle/Mercer/Garrard	1989	Nutrients	Municipal, Agriculture	Aquatic habitat
	Carr Fork	Knott	1980	Suspended solids	Surface mining	Recreation
	Buckhorn	Perry/Leslie	1983	Suspended solids	Surface mining	Recreation
	Stanford	Lincoln	1983	Nutrients	Natural	Water supply
	Wilgreen	Madison	1983	Nutrients	Septic tanks	Recreation
Ohio	Carpenter	Daviess	1980	Shallow basin	Natural	Water supply/aq.habitat
	Jericho*	Henry	1989	Nutrients	Agriculture	Aquatic habitat
	Reformatory	Oldham	1980	Nutrients	Animal holding area	Aquatic habitat
	Mauzy*	Union	1991	Nutrients	Lake fertilization	Aquatic habitat
	George	Crittenden	1991	Nutrients	Agriculture	Aquatic habitat
	Scenic	Henderson	1991	Nutrients	Sediment	Aquatic habitat

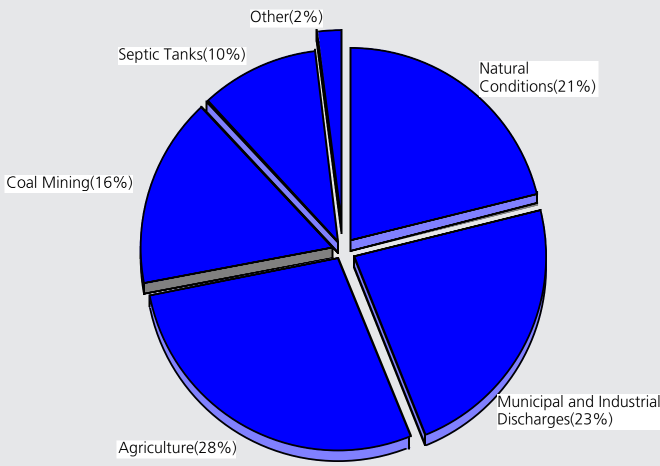
**Lakes not supporting uses—all others partially support uses.*

***Changed from partially supporting uses in 1989 to not supporting uses in 1991.*

Source: Kentucky Division of Water, 305(b) Report, 1992

The Division of Water has not adopted specific criteria to protect lakes. Instead, the Division supports a site-specific approach as being more feasible and realistic in addressing lake pollution problems. Cooperative local and state demonstration projects designed to monitor and address nonpoint source pollution in Taylorsville Reservoir and the Upper Green River Watershed may identify additional strategies for controlling nonpoint source pollution in lakes. But additional local and state measures may be necessary to protect lakes, improve water quality, and maintain their uses for recreation, water supply, and aquatic habitat.

Figure 26
Sources of Lake Pollution in Kentucky



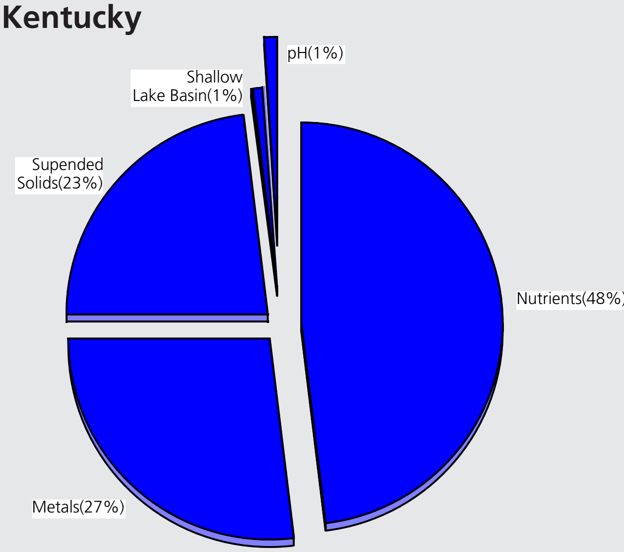
Note: Based on 30,747 lake acres impacted.

Source: Kentucky Division of Water, 305(b) Report, 1992

Runoff pollution from agriculture, mining, and other land disturbing activities is responsible for 54% of the pollution problems in lakes. Industrial and municipal wastewater discharges impact 23% of the lakes where uses have been impaired.

Nutrients, primarily phosphorus, are the reason why many lakes cannot meet their designated uses. Phosphorus is contained in wastewater discharges. Currently, 107 discharges to lakes are permitted, primarily for small sewage treatment plants. Agricultural runoff also contributes to nutrient problems in lakes.

Figure 27
Causes of Lake Pollution in Kentucky



Source: Kentucky Division of Water, 305(b) Report, 1992

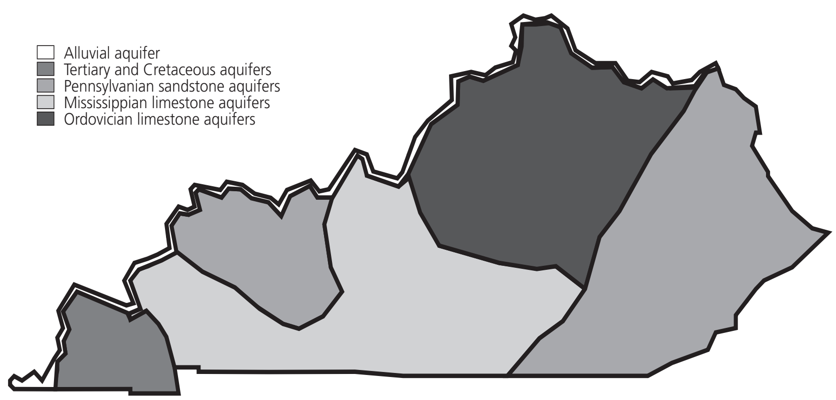
Groundwater

Status of Groundwater Generally Unknown; Contamination Incidents Detected More Frequently

Very little information has been collected in Kentucky regarding the quality of groundwater resources, even though it supplies 20% of the state's drinking water needs. During the past few years, instances of groundwater contamination have been detected with increased frequency across the state. While specific information is not available to determine whether overall groundwater quality is improving or declining, the detection of contamination in a number of private water wells and several community public water systems supplied by groundwater indicates that quality is being threatened statewide. Despite its importance, Kentucky has no comprehensive groundwater protection standards or program.

Groundwater lies beneath the surface of the earth, filling the pores and fractures of soil and rock. This water collects in underground systems called aquifers or hydrologic regions **(Fig. 28)**. Kentucky has five hydrologic regions that yield significant quantities of water through wells and springs. Groundwater resources are particularly vulnerable to contamination due to the state's complex and highly varied geology. Almost 50% of Kentucky's geology is comprised of karst, a land surface characterized by sinkholes, sinking streams, and an interconnected underground network of caves. Since most groundwater comes from surface water entering through sinkholes and sinking streams, it has a high potential to become contaminated by pollutants carried along with the recharging water **(Fig. 29)**.

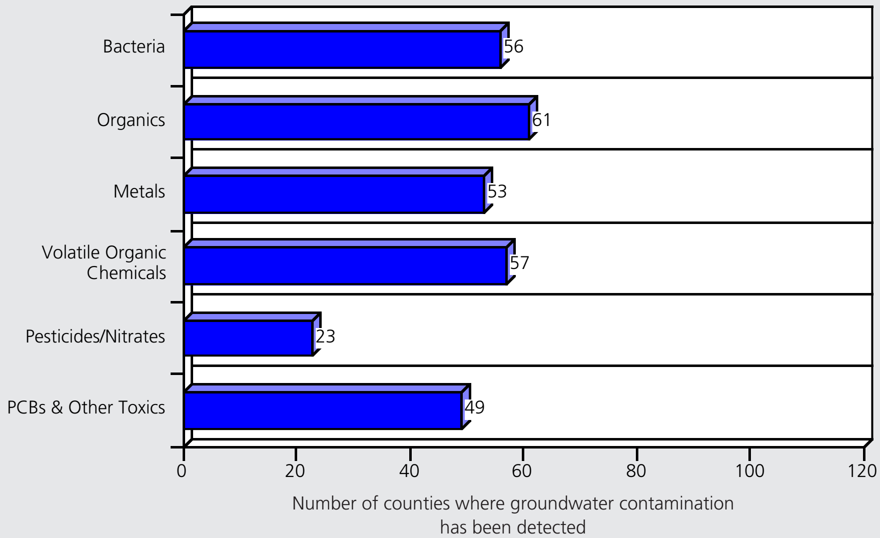
Figure 28
Groundwater Resources in Kentucky



Source: U.S. Geological Survey, National Water Summary, Kentucky, 1984

Very little information has been collected on the quality of groundwater, even though it contributes significantly to drinking water supplies in Kentucky.

Figure 29
Known Instances of Groundwater Contamination in Kentucky



Source: Kentucky Division of Waste Management; Kentucky Division of Water; University of Kentucky Water Well Surveys, 1990–1991

Groundwater is particularly vulnerable to contamination due to the state's complex and varied geologic makeup. Detection of contamination in private wells and groundwater–supplied community drinking water systems indicates that groundwater quality is being threatened statewide.

Major Sources of Groundwater Contamination Include 34,000 Underground Storage Tanks; An Estimated 25% are Leaking

One of the greatest threats to groundwater resources is leaking underground storage tanks **(Fig. 30)**. More than 34,000 underground tanks containing materials such as gas, oil, hazardous materials, and diesel fuel are buried throughout the state. The U.S. EPA estimates that at least 25% are leaking contaminants into the ground. Many of these contaminants move quickly into groundwater and pollute sources of drinking water. For example, the City of Georgetown detected benzene, a major constituent of gasoline, in its public drinking water supply. The city has been unable to identify the source of contamination in Royal Spring, its primary source of drinking water, although leaking underground gas tanks are suspected. Permanent activated charcoal filters and air strippers have been installed to treat Georgetown's water.

State efforts to register and identify leaking underground petroleum storage tanks have been ongoing since 1988. Farm and heating oil tanks are exempt from the registration program. As of December 1991, 1,175 tanks had been replaced and approximately 883 soil cleanups from leaking tanks had been initiated across the state.

Figure 30
Threats to Kentucky's Groundwater

County	Old Landfills*	Septic Tanks**	Unplugged Wells	Underground Storage Tanks	Potential Hazardous Waste Sites	Underground Injection Wells ***
Adair	5	3,269	875	220		220
Allen	3	3,222	933	143		143
Anderson	2	1,922	3	143	4	
Ballard	6	2,036	8	116	2	
Barren	1	6,311	1,692	559	6	5
Bath	1	2,171	126	81	1	
Bell	3	4,876	403	256	4	1
Boone	5	6,353	4	529	9	
Bourbon	5	2,946	12	168		
Boyd	10	7,320	755	474	16	2
Boyle	9	2,456	8	299	7	
Bracken	4	1,294	5	120		
Breathitt	3	2,600	1,705	171		
Breckinridge	16	3,960	986	222	1	
Bullitt	5	7,164	54	310	7	
Butler		2,343	1,063	147	1	4
Caldwell	4	2,394	408	155	3	
Calloway	3	5,442	17	287	5	
Campbell	9	4,482	3	454	8	
Carlisle	2	1,306	7	53	2	
Carroll	7	1,366	20	142	9	
Carter	3	5,404	440	274	3	
Casey	3	3,392	1,036	162		
Christian	10	5,429	1,672	1,585	7	8
Clark	5	2,818	29	264	5	
Clay	7	4,075	3,030	164	4	
Clinton	1	2,552	1,912	140		7
Crittenden	2	1,965	231	105	1	
Cumberland	3	1,437	2,504	125	1	7
Daviess	6	8,248	8,117	863	20	20
Edmonson	3	2,710	463	91		1
Elliott	1	1,449	1,463	59	12	
Estill		2,257	1,505	163	1	4
Fayette	7	10,829	2,643	383	8	
Fleming	5	2,355	28	187	2	
Floyd	13	10,829	2,643	383	8	
Franklin	7	4,026	10	420	6	
Fulton	18	865	13	108		
Gallatin	1	1,006	26	76	1	
Garrard	6	2,083	111	131	1	
Grant	7	2,603	90	181	1	
Graves	7	7,570	30	278	8	
Grayson	3	4,915	900	315	1	
Green	3	2,484	1,047	138	2	25
Greenup	9	5,633	105	287	12	3
Hancock	6	1,217	988	85	7	13
Hardin	7	9,914	444	989	15	
Harlan	9	7992	25	361	7	
Harrison	2	2,360	8	181	3	
Hart	3	3,345	1,089	296	4	8
Henderson	7	4,884	13,072	446	13	85
Henry	4	2,783	34	217	2	
Hickman	3	1,438	6	27		
Hopkins	9	6,795	6,120	499	20	40
Jackson	2	2,575	386	127	2	
Jefferson	28	41,504	56	5,272	87	4
Jessamine	2	3,381	8	205	4	
Johnson	5	5,019	2,620	198		3
Kenton	6	6,763	7	696	9	
Knott	6	4,121	2,350	121		

County	Old Landfills*	Septic Tanks**	Unplugged Wells	Underground Storage Tanks	Potential Hazardous Waste Sites	Underground Injection Wells ***
Knox	5	6,258	1,064	261	2	
Larue	1	2,925	139	100	1	
Laurel	2	9,586	325	528	4	
Lawrence	3	3,005	1,896	132	3	9
Lee	3	1541	2,155	99	9	74
Leslie	4	3,120	2,732	101	1	1
Letcher	6	6,375	2,118	231	1	
Lewis	5	2,984	61	09		
Lincoln	4	4,285	241	204	1	
Livingston	2	2,763	6	120	1	
Logan	6	4,263	540	256	12	
Lyon	1	1,421	2	82		
Madison	6	6,965	57	491	13	
Magoffin	20	3,605	1,822	91		37
Marion	3	2,446	66	143	2	
Marshall	9	6,190	9	407	16	
Martin	1	2,501	1,307	83	3	1
Mason	6	2,657	4	191	1	
McCracken	13	6,836	30	619	15	
McCreary	6	3,394	239	130	1	
McLean	6	2,336	6,640	96	3	19
Meade	8	3,647	273	208	3	1
Menifee	1	1,201	294	75		
Mercer	7	3,532	9	193	5	
Metcalfe	12	2,189	1,236	123	1	3
Monroe	1	3,089	784	91	1	4
Montgomery	5	3,255	24	212	6	
Morgan	3	2,610	126	129	1	
Muhlenberg	11	6,822	6,951	323	6	20
Nelson	3	4,904	54	371	3	
Nicholas	3	1,071	6	80		
Ohio	3	4,796	3,327	292	3	19
Oldham	2	4,891	19	245	10	
Owen	12	1,780	20	63		
Owsley	1	1,123	170	56		
Pendleton	2	1,750	9	144	1	
Perry	7	5,780	2,690	597	3	
Pike	13	20,831	4,225	622	12	2
Powell	3	1,862	360	114	1	2
Pulaski	7	11,261	567	633	5	
Robertson	2	506	8	26		
Rockcastle	3	2,511	51	140		
Rowan	7	3,090	345	152	3	
Russell	5	3,654	735	165		
Scott	6	2,880	17	222	1	
Shelby	2	5,300	10	288	1	
Simpson	2	2,235	219	298	1	2
Spencer	2	1,438	10	95		
Taylor	2	3,614	124	217	1	
Todd	1	2,838	628	134	2	2
Trigg	3	2,520	27	158		
Trimble	1	1,964	1	65	1	
Union	4	2,029	5,726	196	6	18
Warren	6	10,502	2,726	910	12	
Washington	2	1,658	18	96		28
Wayne	3	3,100	639	190	2	
Webster	7	2,969	5,215	127	5	22
Whitley	10	5,815	483	306	5	
Wolfe	5	1,414	963	90	1	31
Woodford	3	2,449	6	177	5	
Total	**626**	**510,637**	**124,280**	**34,655**	**552**	**575**

* Also includes old landfarming operations
**1980 Data for septic tanks
*** used for brine disposal, 2 wells in Jefferson County used for hazardous waste disposal

Source: Kentucky Division of Waste Management; Kentucky Division of Water; Kentucky Department of Health; Kentucky Department of Mines and Minerals; U.S. EPA, 1991

There are a number of sources that contribute to groundwater contamination. An estimated 25% of the 34,655 underground storage tanks may be leaking. Septic tanks and old landfills have degraded groundwater in many areas. Thousands of unplugged oil and gas wells provide direct routes for groundwater contamination. Despite its importance, Kentucky still has no comprehensive groundwater protection standards.

Septic Tanks Most Frequent Source of Bacterial Contamination in Groundwater

The Kentucky Department for Health Services estimates that at least half of the state's private drinking water wells may be contaminated by bacteria due to poor well construction and improper on–site sewage treatment and management. As much as 60% of Kentucky's rural karst groundwater drinking water supplies may be contaminated by sewage, according to the American Cave Conservation Association.

Improperly designed, installed, and maintained septic tanks and other on–site sewage disposal systems are the most frequently reported source of bacterial pollution to groundwater in Kentucky. Many of these systems were installed prior to 1985, without regard to groundwater protection and under conditions now prohibited. On–site sewage disposal systems are potentially impacting sources of groundwater in Logan, Jefferson, Warren, Edmonson, Hart, Barren, Grayson, Rowan, Montgomery, Bath, Menifee, and Morgan counties. Groundwater contamination from improper wastewater treatment plant discharges have also been detected in Marshall County near Calvert City and in Warren County in the Lost River aquifer.

The Cabinet for Human Resources is promoting the use of constructed wetlands for sewage treatment to reduce the problems of failing septic tanks. About 125 of these systems have been installed, primarily for single family homes. Constructed wetlands provide treatment of sewage by filtering the effluent through vegetation which uses the excess nutrients and other organic matter. These systems are particularly beneficial when soil conditions are rocky and the water table is shallow, or when space is limited. The Cabinet reports that monthly monitoring of these systems has shown that most achieve treatment that is equal to that provided by conventional systems. However, some problems with fecal coliform bacteria have been recorded. The Cabinet is continuing to monitor these systems monthly and expects to achieve better results as the technical problems are resolved.

Information on bacterial water–related illness in Kentucky has not been comprehensively collected, although the U.S. Center for Disease Control reports that bacterial contamination may account for 60% of the nationally reported waterborne illness such as dysentery, hepatitis, and meningitis. In 1982, an outbreak of hepatitis–A at Buttermilk Springs in Meade County resulted in one fatality and 110 cases of illness. Tests showed that many wells in the area had bacterial contamination.

Most Solid Waste Landfills Suspected of Leaking Contaminants into Groundwater

The disposal of hazardous, solid, and toxic wastes is increasingly impacting the quality of the state's groundwater. The Kentucky Division of Waste Management (DWM) has identified 626 inactive solid waste landfills and landfarm operations, potentially leaching contamination into groundwater. Contamination was detected at 181 of the 240 sites investigated. Groundwater pollution was confirmed at 26% of these sites. Groundwater contamination exceeding primary and secondary drinking water standards has also been detected at 26 of the 32 municipal solid waste landfills in Kentucky currently monitoring groundwater quality and has been verified at 16 of the 17 state Superfund hazardous waste sites.

Lagoons, once used by industry and municipalities for the disposal of industrial and domestic wastes, have also caused groundwater contamination. Since limited records are available, it is not possible to know how many old inactive lagoons are polluting groundwater resources in Kentucky. High levels of PCBs and other toxic substances were discovered in groundwater near a treatment lagoon used by Rockwell International in Russellville. The company has since been ordered to clean up the contamination and is assessing options.

The state now requires KPDES water permits for discharges to waste ponds and surface impoundments. Twenty permits are currently active for six industrial, 12 wastewater, one oil lease, and one water plant. In addition, state water permits have been issued for discharges to approximately 50 ponds used by coal–fired power plants to dispose fly ash generated during the production of electricity. Groundwater monitoring is currently not required at waste ponds or surface impoundments so the extent of their impacts cannot be assessed.

Direct discharges to sinkholes are also permitted by DOW where surface water is unavailable, primarily in Western Kentucky. Currently, 40 KPDES water permits are in effect for industries, schools, small package treatment plants, oil wells, and water plants which discharge into sinkholes. The degree to which these discharges impact groundwater is generally unknown since groundwater monitoring is not required.

120,000 Unplugged Wells Provide Direct Pathway for Contaminants to Enter Groundwater; 164 Plugged During Past Five Years

Contaminants from industrial and municipal wastewater discharges and pollutants from farmlands, mine sites, and other sources can enter groundwater through surface water or through direct routes such as unplugged oil and gas wells and sinkholes.

The Kentucky Department of Mines and Minerals (DMM) estimates there are 120,000 unplugged oil and gas wells in the state. This may be a conservative estimate since thousands of wells were drilled prior to any official recordkeeping. Since 1986, DMM has plugged only 164 of these abandoned wells at an average cost of approximately $1,800 per well.

In addition, more than 5,000 oil and gas wells operating in Kentucky have had their bonds forfeited. To cover the closure of these wells, the state requires oil and gas well operations to post financial bonds. DWM currently holds $13.3 million in oil and gas bonds. During 1991, the number of oil and gas bonds released compared to the number forfeited were almost even. Approximately, 229 bonds were forfeited amounting to $298,000, most of which were for older wells. In comparison, 266 bonds were released in 1991, representing a total of $396,000 in bonds. The ability of the state to plug old abandoned wells and reclaim forfeited sites has been limited due to inadequate bonds. Only 100 wells will be plugged by DMM in 1992 due to lack of resources.

The General Assembly increased oil and gas bond rates in 1990. Bond rates were raised to $10,000 for multiple wells and up to $5,000 for individual wells based on well depth. Currently, DMM is using the interest from existing bonds to plug old wells. The national Oil Pollution Act (OPA) of 1990 may also assist. OPA funds are currently being used to plug some wells in the Owensboro area. Additional funds, however, will be needed if Kentucky is to minimize groundwater risks caused by abandoned wells. A measure to require oil and gas companies to reclaim sites, test water quality, and reach agreement with landowners before oil and gas drilling begins was introduced in the 1992 General Assembly, but failed to pass.

573 Oil Brine Injection Wells Permitted in State; Violations Increasingly Recorded

Improper underground injection of wastes also poses risks to groundwater. Some industrial wastes and oil field brines are disposed through injection wells normally drilled 600 to 2,500 feet deep. There are currently two hazardous waste injection wells operated by DuPont Chemical in Louisville. The company is permitted, under state and federal requirements, to inject 70 million pounds of dryweight hydrochloric acid a year until its permit expires in 2000. During 1989, the company injected 39 million pounds of acid, but has since reduced that amount to 9.4 million pounds in 1990 after a market for this waste was identified.

Approximately 573 brine injection wells are permitted in Kentucky by the U.S. EPA for the disposal of salty brine water produced from oil and gas drilling operations. In addition, a number of injection wells are used for stormwater runoff in urban areas. It is not known how many of these stormwater wells operate in the state, since permits have not been issued, although the U.S. EPA is required by law to permit all underground injection wells. The U.S. EPA reports that several stormwater injection wells are in use in the karst areas of Bowling Green and Horse Cave.

If properly constructed and operated, injection wells pose minimal risk to groundwater. Because these wastes are injected below the water table, no groundwater monitoring is required. However, 120 enforcement cases at brine injection wells during the last 18 months in Kentucky indicate problems. These cases led to administrative orders by the U.S. EPA to address reporting deficiencies and problems with injection well integrity. Recent applications to discharge coal slurry through injection wells have been rejected by the U.S. EPA.

7,520 Water Wells Drilled in State Since 1985; Groundwater Database Needed to Better Assess Quality

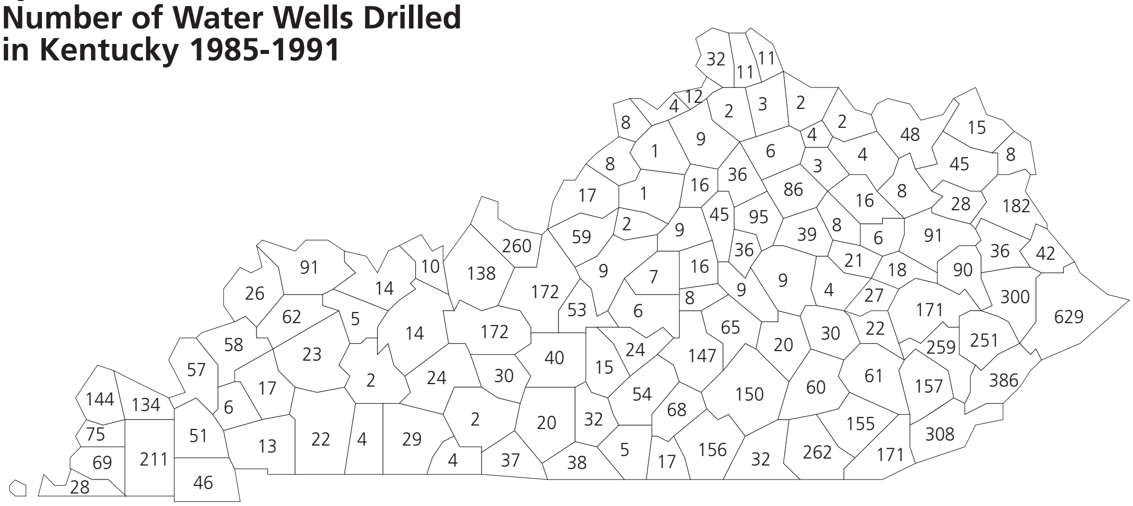
Between 1985 and 1991, 7,520 drinking water wells were drilled in Kentucky. The greatest number are found in Pike County (629), followed by Letcher (386), Harlan (308), Floyd (300), Whitley (262), Perry (259), and Graves (211) counties **(Fig. 31)**. Some programs have been established to protect water well supplies. Since 1985, state regulations have required all water well drillers to be certified. In 1991, monitoring well drillers were added to the certification program. Currently, 188 drillers are certified in Kentucky (74 water well, 54 monitoring well, 60 water well/monitoring well). A few local groundwater protection programs have also been initiated. For example, Owensboro and Calvert City are in the process of developing programs to protect groundwater recharge areas.

But much more is needed to protect groundwater resources in Kentucky. In addition to groundwater protection standards, there is a critical need for the consistent collection and automation of data in order to assess overall groundwater quality and identify problems. A groundwater repository, to be located within the Kentucky Geological Survey, may prove to be a valuable tool to the state, if properly coordinated and funded. The Department for Environmental Protection is also in the process of standardizing the collection and automation of groundwater data and information among Divisions to assist with permit and enforcement actions which would prove beneficial if implemented.

Kentucky relies greatly on groundwater for water supplies. Since 1985, 7,520 water wells have been drilled. Currently, 188 water and monitoring well drillers are certified by the state.

Figure 31

Number of Water Wells Drilled in Kentucky 1985-1991



Source: Kentucky Division of Water, 1991

Drinking Water Quality

Public Drinking Water Bacteriological Violations Decreasing; Merging Smaller Systems Has Assisted in Improving Overall Drinking Water Quality

Surface and groundwater provide drinking water to the state's 1991 projected population of 3.71 million **(Fig. 32)**. While the quality of drinking water is considered good, new standards and improved methods of testing have revealed many potential threats to this resource, mainly in the form of man–made chemicals.

The Safe Drinking Water Act of 1974 regulates public water supplies to ensure the nation's drinking water is safe for consumption. Presently, public water systems must monitor or provide treatment for 60 drinking water contaminants. Newly proposed federal standards will increase this number to nearly 200 by the year 2000. The new standards will assist in providing a more detailed analysis of drinking water quality.

Generally, water provided by the state's 859 public drinking water systems (those which serve 25 or more people) meets the Safe Drinking Water Act standards. The standards are set for three general categories of contaminants: bacteriological, organic, and inorganic chemicals. Persistent public drinking water violations for bacteriological and turbidity standards in Kentucky have decreased more than 90% during the last ten years **(Fig. 33)**. The steady decrease in violations of primary drinking water standards warrants optimism that drinking water quality is improving for many Kentuckians.

The merging of smaller and unviable systems has clearly assisted in improving overall drinking water quality. Systems serving 101 people or less are the greatest violators of drinking water standards in Kentucky **(Fig. 34)**. These systems generally cannot afford to improve their technology or hire full–time personnel. Since 1980, 334 small drinking water systems have merged **(Fig. 35)**.

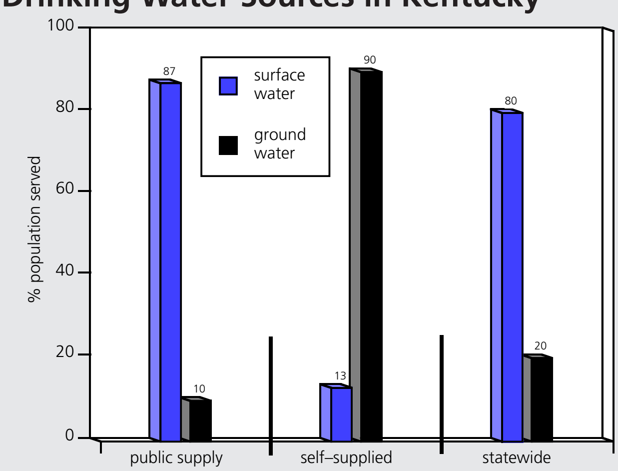
Bacteriological contamination is one of the most common violations of drinking water standards in the state **(Fig. 36)**. While bacteriological drinking water violations have decreased steadily during the last ten years, the total number of instances of bacteriological contamination leading to boil water notices and advisories increased significantly in 1990 and 1991 **(Fig. 37)**. According to DOW officials, this increase reflects a greater awareness by public drinking water system managers of the need to issue advisories and notices.

Drinking water violations of turbidity standards have also decreased in recent years. Turbidity, or cloudiness, caused by small particles of silt, clay, or other matter can interfere with disinfection and can also allow pathogenic organisms to survive.

Surface and groundwater provides drinking water to 3.71 million Kentuckians. While the quality of drinking water is considered good, new standards and testing methods have revealed threats, mainly in the form of man–made chemicals.

Figure 32

Drinking Water Sources in Kentucky



Source: U.S. Geological Survey, Water Use in Kentucky, 1990 (preliminary)

Figure 33
Public Water Systems with Persistant Violations of Bacteriological and Turbidity Standards by River Basin

Basin	1985	1986	1987	1988	1989	1990	1991
Licking River	6	1	2	1	1	0	1
Kentucky River	29	20	17	14	25	25	18
Cumberland	7	4	2	4	3	2	2
Salt River	2	2	0	1	1	0	-
Green River	11	4	5	7	5	5	1
Mississippi	1	0	0	0	0	1	-
Ohio & Tributaries	9	5	2	4	4	1	1
Big Sandy	5	3	3	2	2	3	3
Basins not coded*	77	28	46	50	61	34	32
Total	**147**	**67**	**77**	**83**	**102**	**71**	**58**

** Information was not coded by basin for the Little Sandy, Tygarts, Tradewater, and Tennessee rivers in 1985-91. In 1991, the Mississippi and Salt basins were not coded.*
Source: Kentucky Division of Water, 1992

Generally, water provided by the state's 859 public drinking water systems meets federal and state standards. Public water systems in the Kentucky River Basin continue to have the greatest problems in meeting bacteriological and turbidity standards.

Drinking water systems serving 101 people or less are the greatest violators of drinking water standards in Kentucky. These systems generally cannot afford to improve technology or hire full–time personnel.

Figure 34
Public Drinking Water Systems in Kentucky with Violations

Facility Size (Population Served)	Number of Systems	Number of Systems w/ Violations	Number of Drinking Water Violations	% of Violations
<101	212	109	416	47%
101-500	201	93	233	26%
501-1,000	69	34	76	9%
1,001-2,500	131	37	51	6%
2,501-3,300	53	16	30	3%
3,301-5,000	50	10	17	2%
5,001-10,000	80	22	41	5%
10,001-50,000	56	14	18	2%
50,001-75,000	4	1	1	<1%
>100,000	3	0	0	-
Total	**859**	**336**	**883**	

** Includes violations of drinking water standards (MCLs) and monitoring and reporting violations*
Source: Kentucky Division of Water, 1992

Figure 35
Number of Drinking Water System Mergers in Kentucky

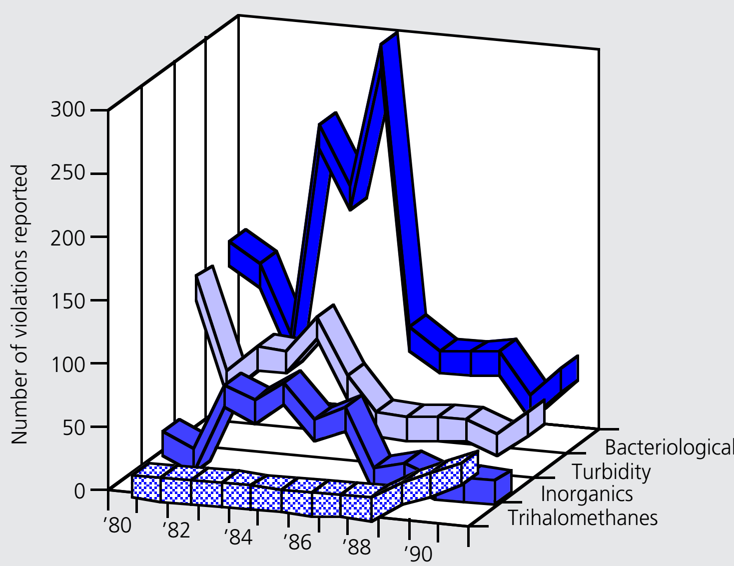
Year	Number of mergers
1980	3
1981	9
1982	46
1983	23
1984	18
1985	52
1986	40
1987	33
1988	25
1989	35
1990	30
1991	20
Total	**334**

Source: Kentucky Division of Water, 1992

The merger of small and unviable drinking water systems has helped improve the quality of public drinking water in Kentucky. Since 1980, 334 systems have merged.

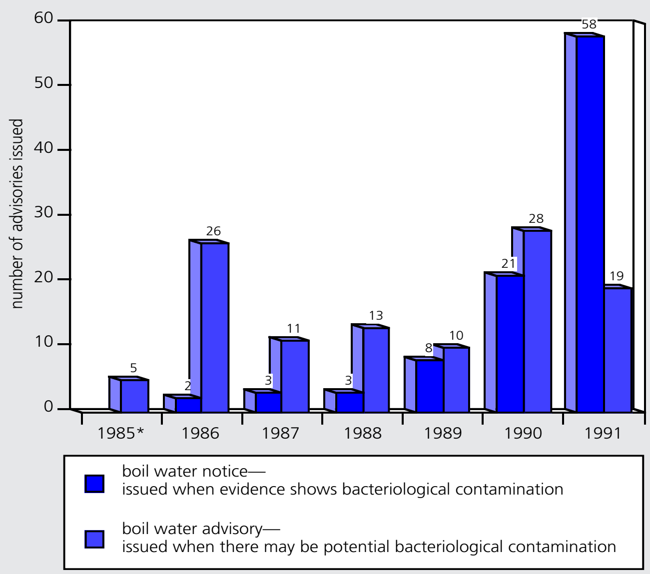
Violations of some of the state's drinking water standards have declined significantly. Bacteriological and turbidity violations have decreased by more than 90% during the last 10 years.

Figure 36
Violations of Selected Drinking Water Standards in Kentucky



Source: Kentucky Division of Water, 1992

Figure 37
Public Drinking Water Boil Water Notices and Advisories Issued in Kentucky



** Notices required beginning 1985.*
Source: Kentucky Division of Water, 1992

While persistent violations of bacterial drinking water standards have declined, boil water notices increased significantly in 1990 and 1991. This may reflect greater compliance by public drinking water systems to report problems and issue notices and advisories.

Organic Chemical Contamination of Public Drinking Water Supplies an Emerging Threat; 60 Systems Had Detectable Levels of Regulated Chemicals

Organic chemicals pose a potential problem to Kentucky's drinking water. These synthetic or man–made compounds can cause a range of health effects from skin rashes to terminal illness. This category of pollutants includes:

- pesticides,
- herbicides, and
- volatile organic chemicals (VOCs) which are highly reactive, such as benzene and trichloroethylene, and disinfection by–products known as trihalomethanes (THMs).

DOW requires that public drinking water systems test for a variety of these chemicals, including six agricultural pesticides. Results of those tests have detected none of the pesticides above health–based standards in the finished water. Testing scheduled to begin in 1993 for 18 additional pesticides, including four that are widely used in Kentucky, will assist in providing a broader perspective of pesticide threats to public drinking water supplies.

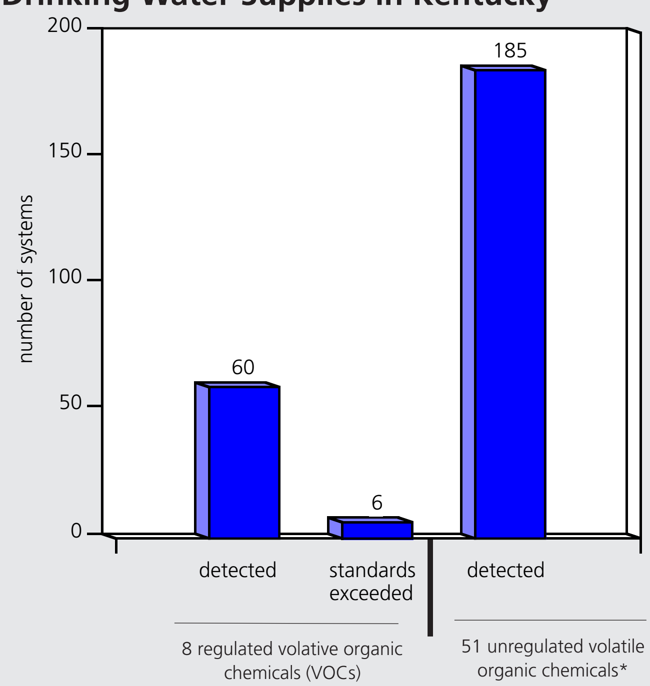
Public drinking water systems are also required to test for eight regulated VOCs which are used in industrial solvents, degreasers, and cleaners **(Fig. 38)**. Monitoring conducted in 1987 revealed that 60 of the systems had measurable levels of one or more of the eight regulated VOCs. Six systems were discovered to be supplying water with VOCs exceeding the standards **(Fig. 39)**. Systems which detected high levels of these chemicals were required to treat the water or find an alternative water supply.

The detection of substances such as benzene, vinyl chloride, and acetone reveals that toxic and hazardous contaminants in drinking water are a potential threat to public health. Public drinking water systems must test for organic chemicals every three years. Systems with detectable organic chemical contamination are required, at a minimum, to perform quarterly testing for these substances for three years.

ORSANCO, a compact of eight states that monitors the Ohio River, has detected chemicals such as benzene and chloroform above acceptable levels in 10% to 90% of the daily samples tested at Ohio River water supply intakes during 1991. The compact has expressed concern regarding the presence of these chemicals. Water utilities have been able to treat for these chemicals, but the sources of these contaminants have not been identified. The Ohio River provides drinking water to 3 million people in Kentucky, Ohio, Pennsylvania, Illinois, Indiana, New York, Virginia, and West Virginia. Currently 61% of the Ohio River bordering Kentucky cannot fully be used for public water supplies.

Public water systems have also tested for 51 unregulated VOCs to help the U.S. EPA collect data on which to base future standards. Testing of 575 public drinking water systems in Kentucky in 1987 revealed that 185 had detectable levels of one or more of the 51 unregulated VOCs. The primary VOCs detected were disinfection by–products resulting from the water treatment process. Disinfection by–products (primarily trihalomethanes known as THMs) are formed when chlorine reacts with decaying matter during the water treatment process. Currently, 240 public drinking water systems in Kentucky are required to monitor for THMs. The U.S. EPA is expected to issue a more stringent THM standard within the next two years to further reduce the amount of these chemicals in drinking water.

Figure 38
Organic Chemical Contamination of Public Drinking Water Supplies in Kentucky



**103 systems detected disinfection by–products (THMs).*
82 systems detected other nonregulated VOCs.
These tests will assist the U.S. EPA develop additional VOC standards.
Source: Kentucky Division of Water, 1991

A potential threat to Kentucky's drinking water is organic chemicals. These compounds, at certain levels, can cause a range of adverse health effects. In 1987, tests revealed that 60 public drinking water systems had measurable levels of eight regulated chemicals and six exceeded standards.

Figure 39
Public Drinking Water Systems in Kentucky That Have Exceeded Volatile Organic Chemical Standards

System	Date Detected	Contaminant	Source	Current Status
Georgetown	Dec. 1988	Benzene	Unknown	Changed source, activated charcoal filters and air strippers used
Carrollton	Dec.. 1988	Trichloroethylene	Unknown	Activated carbon used to remove contamination
Yerkes Senior Citizen	Jan. 1990	Benzene	Leaking underground storage tank	Discontinued well and put in above ground tank and hauled water
Paducah	Dec. 1988	1,2 Dichloroethane	Tennessee River contamination (industry)	Activated carbon used to remove contaminant
Holiday Mobile Home Park (Dayhoit)	Feb. 1989	Vinyl chloride	Industrial activity	Water line run from Black Mt. Utility Dist. in Evarts
Tolu Elementary	Aug. 1990	Benzene	Leaking underground storage tank	Installed water tank and hauled water

Source: Kentucky Division of Water, 1991

The detection of benzene, vinyl chloride, and acetone indicates that toxic chemicals in drinking water are a potential health threat. Public drinking water systems in Kentucky must test for organic chemicals every three years. There is no such testing provided for private drinking water supplies.

Health Risks from Lead Contamination an Increasing Concern; U.S. EPA Finalizes More Stringent Standard

All public drinking water systems are required to test for lead contamination. No violations of the current lead standard of 50 parts per billion have been found in Kentucky. The U.S. EPA, however, recently finalized a more stringent lead standard of 15 parts per billion at the tap, and 5 parts per billion throughout any public water system because of its potential health–related impacts. The state has not yet adopted this standard.

Lead is a cumulative poison that can cause serious health affects including brain damage, increased blood pressure, premature birth, low birth weight, and nervous system disorders. Young children are especially at risk from high levels of lead in drinking water. Tap water tests conducted in Louisville, Bowling Green, and Owensboro indicate that fewer than 10% of the homes tested had lead levels above the proposed 15 parts per billion. According to DOW, most public water systems in Kentucky will be able to meet this new action level. Some water systems are replacing service lines containing lead and asbestos. The Louisville Water Company, for example, has replaced 20,000 of the 50,000 lead service pipes leading to residences.

Other inorganic chemicals which must also be monitored by public drinking water systems generally include metals, nitrates and, in the future, asbestos. Industrial and municipal discharges, landfills, and agricultural fertilizers all contribute to inorganic chemical contamination of drinking water. Violations of inorganic chemical drinking water standards in public systems have been detected less frequently in recent years in Kentucky as can be seen in Figure 36.

48 Counties Depend on Groundwater for Public Supplies; Contamination Detected in Several Systems

Forty–eight Kentucky counties depend upon a combination of both surface and groundwater for their public drinking water supplies. Bacterial contamination of public water supply systems using groundwater as a source varies from year–to–year. In 1988, 25 systems were in violation of drinking water standards for bacteria. That total increased in 1989 to 33, decreased to 16 in 1990, and increased slightly in 1991 to 19.

Tests conducted in 1988 also detected regulated VOCs in 24 of the state's 140 public drinking water systems relying on groundwater. This decreased to 19 systems in 1990, and 16 in 1991. The chemicals most often detected were 1,4–dichlorobenzene and trichloroethylene, which are solvents used in various commercial operations and industrial processes such as dry cleaning, furniture stripping, and automobile repair. The population at risk from organic chemicals in groundwater-supplied systems in Kentucky during 1991 was 19,545, compared to 39,439 in 1990.

Half of Private Wells May be Contaminated by Bacteria; Agricultural Chemicals Detected in Water Wells Vary

A number of Kentuckians rely on private wells for drinking water **(Fig. 40)**. Water well surveys conducted in recent years reveal a variety of contamination problems. A 1988 DOW study of 111 wells in Bath, Montgomery, Rowan, Morgan, and Menifee counties detected bacterial contamination in 90% of the hand–dug wells and 33% of the drilled wells. Tests performed by Morehead State University researchers in 1988 revealed 50% of 1,761 water wells tested across the state were contaminated by bacteria. The study also revealed that, of the 468 cisterns tested, 27% were contaminated with bacteria and 43% of 231 springs sampled had unsafe levels of bacteria. The Kentucky Department for Health Services estimates that at least half the wells in Kentucky may have bacterial contamination problems, primarily due to poor well construction.

The level of agricultural chemicals in 888 private water wells was also tested in 1989 by the University of Kentucky and the Kentucky Farm Bureau in a nonscientific survey. The tests detected various levels of nitrates in all the wells, and 6% had levels exceeding health standards. Results from the second round of testing conducted in 1990 revealed that 4.2% of the 2,032 samples taken exceeded drinking water standards for nitrate. Nitrates, found in fertilizers and other products, can cause stomach cancer and a rare, but critical, infant disease known as methemoglobinemia.

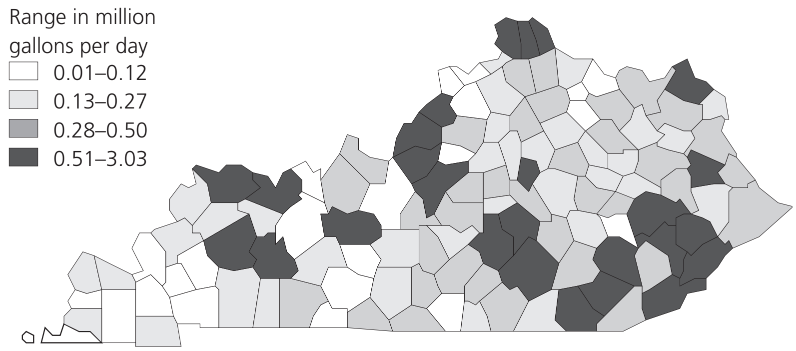
Pesticides are also a threat to private well water supplies. Thirty–one percent of 200 wells tested during 1989 in Christian, Todd, Hickman, and Henderson counties had detectable levels of triazines, a common class of herbicides used on Kentucky farmlands. One well exceeded acceptable health standards for triazines.

Toxic substances such as arsenic, industrial solvents, and radioactive contamination have also been detected in water wells in some areas of the state. In 1991, four wells were discovered exceeding standards for arsenic in Katherine Station in Bullitt County. Neither the state or federal government have provided alternative water supplies to these homes. Eleven wells in Logan County near Keysburg were discovered to be contaminated with trichloroethylene in 1992. The source is an old landfill which closed in 1979. The state has provided affected residences with alternative water supplies and has ordered the site's cleanup.

Many other wells may be contaminated with toxic and hazardous substances, however, there is no comprehensive testing or monitoring program in place to determine the quality of drinking water from private wells and other self-supplied sources including cisterns and springs. The Kentucky Department for Health Services (DHS) will test wells for bacterial contamination upon request. Water well drillers are required to disinfect newly drilled wells and test them for bacteria.

Figure 40

Private Well Groundwater Withdrawals



50.1 million gallons a day

Source: U.S. Geological Survey, Water Use in Kentucky, 1990 (preliminary)

In addition to 48 counties that depend on both surface and groundwater for public water supplies, thousands of Kentuckians rely on private wells for water. It is believed that half of these water wells may be contaminated by bacteria.

Coal Mining Disrupts Water Supplies; Additional Groundwater Protection Measures Needed

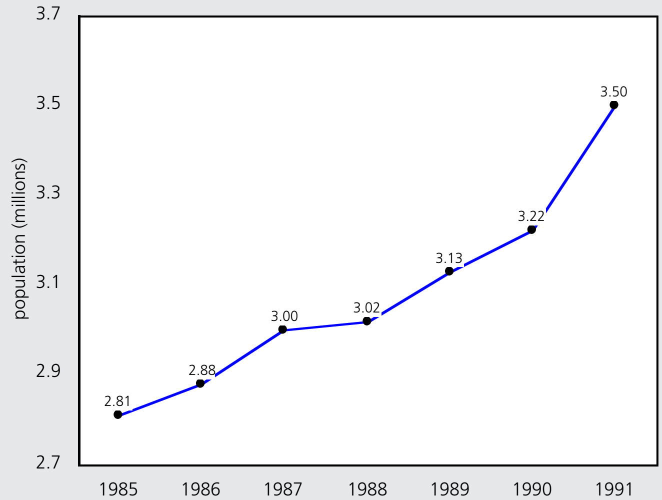
Coal mining discharges as well as runoff from abandoned mines have also affected groundwater in several areas. The Kentucky Division of Abandoned Mine Lands (DAML) has received a number of requests from local governments for assistance in developing public water supplies where existing groundwater sources have been impacted by past mining practices. DAML has assessed groundwater problems at a number of sites and has provided funds for water line extensions in 20 areas, most of which are in Eastern Kentucky. In 1991, DAML used $600,000 received from the federal Abandoned Mine Land Fund to assess instances of water pollution caused by past mining practices. Mining activities resulted in nearly 1,500 complaints in 1990, many concerning impacts to private water supplies.

Kentucky has neglected its groundwater resources for too long. The loss of private water wells from pollution and other activities has had major impacts, particularly on rural areas of the state which depend on groundwater as a primary drinking water source. Kentucky should move forward and establish groundwater standards and regulatory requirements to protect this valuable resource. Groundwater programs to protect recharge areas and other efforts to prevent contamination should receive high priority and be expanded across the state.

Population Served by Public Drinking Water Increases to 3.5 Million; Drinking Water Infrastructure Five–Year Funding Needs Estimated at $400 Million

Many public drinking water systems with chronic violations are unable to meet standards because of infrastructure deficiencies or improper operation and maintenance. The increasing costs of meeting drinking water standards have resulted in the merger of 336 systems since 1980. Other communities have either built new plants, repaired, or expanded their existing drinking water facilities. During the last ten years, DOW has approved 7,285 system upgrades, expansions, construction, and repairs for public drinking water systems, with a significant federal, state, local, and private investment of millions of dollars. These expansions have increased the population served by public drinking water systems from 2.8 million people in 1985, to 3.5 million in 1991 **(Fig. 41)**. As expected, these improvements have also resulted in rate increases **(Fig. 42)**.

Figure 41
Population Served by Public Drinking Water Systems in Kentucky



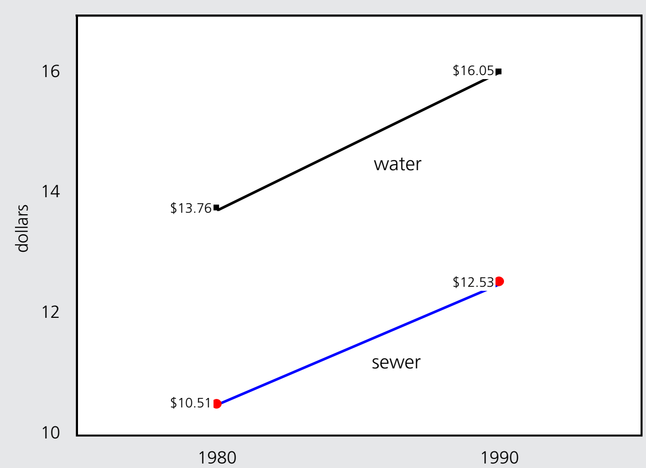
Note: 1991 data based on survey of public drinking water systems.

Source: Kentucky Division of Water, 1992

The construction and upgrading of public drinking water systems in Kentucky has increased the population served from 2.8 million in 1985 to 3.5 million in 1991.

Over the last 10 years, 7,285 public drinking water system upgrades, expansions, and construction requests have been approved by the state, resulting in an investment of millions of dollars. As expected, these improvements have resulted in rate increases.

Figure 42
Average Monthly Residential Water and Sewer Bills in Kentucky*



**Average rates for those systems regulated by the Kentucky Public Service Commission.*

Source: Kentucky Public Service Commission, 1992

Kentucky established a state revolving loan fund in 1988 to provide low interest loans to water utilities. In 1990, $30 million was appropriated to fund drinking water infrastructure projects in four Area Development Districts: Gateway, Big Sandy, Kentucky River, and Cumberland Valley. As of October 1991, $3.8 million had been awarded from the fund for projects in Martin, Leslie, and Pike counties. The Department of Local Government estimates the state will need an estimated $400 million during the next five years to fund 267 high priority drinking water projects.

Some communities have chosen to let the private sector own and operate public drinking water systems to help relieve municipalities of the costs and difficulties associated with meeting drinking water standards. In 1985, the most recent data available, 221 of the state's public drinking water systems were privately–owned and operated.

The increasing costs to treat and distribute water have focused additional attention on repairing and maintaining water distribution lines. Some water systems in Kentucky lose as much as 50% of their processed water each day due to old and poorly maintained distribution systems. Both the state and the Kentucky Rural Water Association are encouraging efforts to detect and prevent leaks—one of the most cost–effective measures a system can take to hold down costs and improve the quality and quantity of its water.

Another drinking water infrastructure problem is the cross connection of pipes. Cross connections are permanent or temporary links between potable water and water of unknown quality which may, under certain conditions, allow contamination of drinking water supplies. The extent of this problem and its impacts on drinking water are not well known in Kentucky, but they are believed to be very significant.

Water Availability

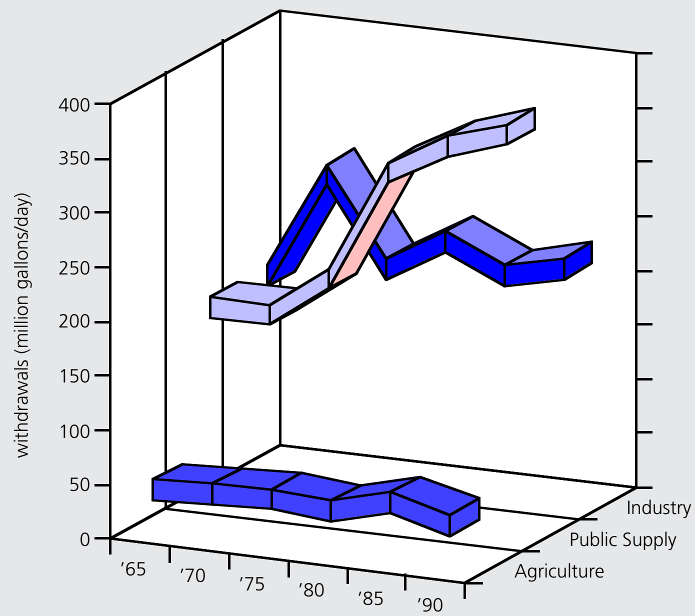
According to the U.S. Geological Survey, Kentuckians withdraw more than 4 billion gallons of water every day **(Figs. 43 and 44)**. Nearly 95% of this amount is supplied by surface water sources and 5% from groundwater sources. About 10% is withdrawn for public use with the remainder supplying agriculture, industry, and commercial needs. Much of the water withdrawn from streams and rivers is used by the state's 16 hydroelectric generation plants or for cooling purposes at the state’s 58 coal–fired power plant units and then returned to the stream or river.

The availability of water is variable, due in part to precipitation, treatment, distribution/storage capabilities, competitive uses, and natural factors. Droughts have disrupted raw water supplies in several Kentucky communities, while flooding has caused millions of dollars in damages to homes, businesses, and communities.

Kentuckians withdraw more than 4 billion gallons of water every day. About 10% is used for drinking, with the remainder supplying industrial, agriculture, and commercial needs.

Figure 43

Surface Water Use Trends in Kentucky (selected categories)

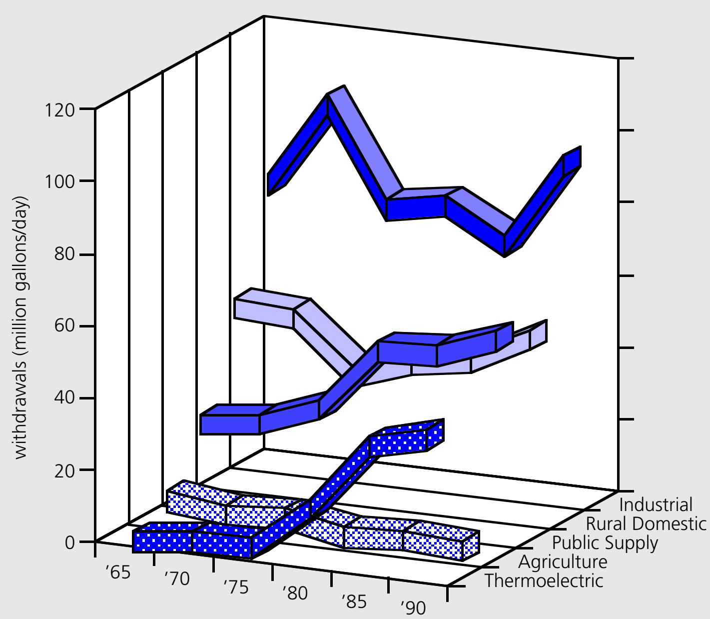


Source: U.S. Geological Survey, Water Use in Kentucky 1965-85, 1990 preliminary

About 5% of the total water withdrawn in Kentucky is supplied by groundwater resources. Groundwater continues to play a significant role as a source of drinking water, particularly in rural areas.

Figure 44

Groundwater Use Trends in Kentucky



Source: U.S. Geological Survey, Water Use in Kentucky 1965-85, 1990 preliminary

29 Kentucky Communities Vulnerable to Droughts; Local Water Supply Plans in 52 Counties Will Assist in Assessing Needs

Many Kentucky communities have become increasingly aware of their vulnerability to water shortages as a result of experiencing a water crisis at one time or another. Raw water, while seemingly abundant in Kentucky, is geographically limited. With increased growth and infrastructure limitations, several communities face threats of water shortages. In 1988, there were 20 public water system shortages related to insufficient treatment capacity, and 14 from distribution and storage problems. DOW currently classifies 29 community water systems as vulnerable to droughts, and lists another 12 as potentially vulnerable **(Fig. 45)**. These 29 public water systems serve 371,760 individuals, approximately 10% of the state's population.

Water shortages have caught many Kentucky communities by surprise and unprepared to manage limited supplies. Both droughts and changes in competitive use can contribute to water shortage emergencies. Competitive water use disputes led to the issuance of a gubernatorial Executive Order in 1983 calling for water conservation, and another in 1988 declaring a water shortage emergency. These orders gave the state power to allocate water among competing users.

The DOW water quantity management program is based on a water withdrawal permitting program. This program currently allows the withdrawal of approximately 786 million gallons of water a day through 587 permits. The program exempts agriculture, electric generating stations, and oil and gas operations from the permitting requirements. These exemptions amount to 81% of the water withdrawn in the state. Because of these exemptions, and incomplete data, the permitting program cannot accurately project the impacts of withdrawals on community water supplies.

Most local water system managers also have no accurate measurement of the available supply of water and no historical record with which a measurement can be compared, according to DOW. Counties and cities have been encouraged to prepare water shortage and long–range water plans, but few have. To better understand current needs and prepare for future water uses and needs, the legislature passed a measure in 1990 requiring counties to develop single or multi–county water supply plans. Limited state grant funds were provided, to be distributed based on a community's drought vulnerability. In 1991, 52 counties applied for water supply grant funds through eight regional applications. The data collected through these plans will provide communities and the state with a basic understanding of water availability and trends, and will hopefully assist communities to better plan for their long–range water supply needs.

Figure 45
Drought–Vulnerable Water Supply Systems

County	System	Population (%)[1]
Bath	Owingsville WW	25
Bourbon	Paris Municipal WW	61
	N. Middletown Municipal WW	6
Breathitt	Jackson Municipal WW	17
Carter	Olive Hill WW	24
Christian	Crofton Water Department	3
Cumberland	Burkesville Municipal WW	40
Fayette	KY–American Water Co.	99
Grayson	Caneyville Municipal WW	7
Hardin	Elizabethtown Municipal WW	23
	Hardin County WD #1	27
Harlan	Cumberland WW	9
	Green Hills WD	1
	Harlan Municipal WW	18
	Lynch Water Plant	4
Jackson	McKee Municipal WW	11
Letcher	Jenkins WW	13
	Whitesburg Municipal WW	5
Magoffin	Salyersville Municipal WW	18
Morgan	West Liberty W & S	29
Muhlenberg	Greenville Municipal WW	22
Ohio	Fordsville Water System	7
Owen	Owenton WW	31
Owsley	Booneville W & S Dept.	59
Perry	Hazard Water Dept.	36
Scott	Stamping Ground WW	3
Todd	Todd County Water District	59
	Guthrie Water Works	21

[1]*percent of county population served by the system*

Source: Kentucky Division of Water, 1991

Many Kentucky communities have become increasingly aware of their vulnerability to water shortages. Twenty–nine water systems, serving 10% of the state's population, are classified as vulnerable to droughts. Twelve others are listed as potentially vulnerable.

All Counties Have Flood Preparedness Plans; 61 Communities Vulnerable to Floods Have No Floodplain Ordinances

Flooding is one of the most significant natural hazards that regularly occurs in Kentucky **(Fig. 46)**. Major flooding occurs within the state almost every year, and it is not unusual for several floods to occur in a single year. The state experienced significant floods in 1973, 1975, 1977, 1982, 1984, 1988 and 1990. In 1988, floods were responsible for eight deaths and millions of dollars in damage.

Two types of flooding typically occur in Kentucky, flash floods and river basin floods. Flash floods occur in all parts of the state, particularly in the eastern portion where they are abetted by the region's mountainous terrain, and numerous streams and riverbeds. Basin floods are common along the state's 13 major rivers. Cities such as Frankfort, Louisville, Owensboro, and Paducah have been seriously affected by river basin floods. Generally, the lack of community preparedness for flooding has been a major problem in Kentucky. But all counties now have emergency flood preparedness plans in place, which should improve response capabilities.

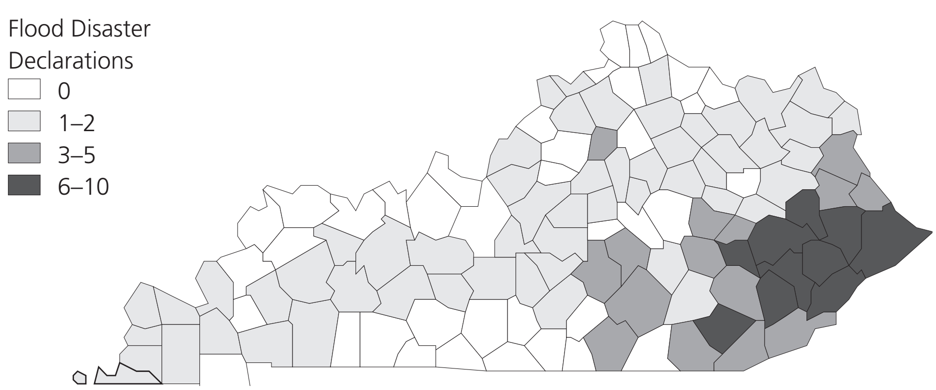
With 89,431 miles of streams, it has been difficult to control floodplain development in Kentucky. The state generally relies on local governments to limit this development. Currently, 257 communities have enacted ordinances to manage development in flood hazard areas to protect public safety, reduce damage to property, and qualify for the National Flood Insurance Program. These ordinances require local approval of activities in a floodplain, but the actual enforcement of local floodplain ordinances in Kentucky appears weak. In addition, 61 communities vulnerable to floods have yet to adopt local floodplain ordinances.

The Division of Water also requires state floodplain permits for any activity that will obstruct the flow in a 100–year floodplain, such as bridges and building construction. The program exempts some activities, including farming. The increasing number of floodplain permits issued by the Division indicates that there is stricter adherence and enforcement of floodplain development requirements. In 1986, 151 state floodplain permits were issued, compared to 244 in 1990. Increased enforcement of local floodplain ordinances and federal and state laws, as well as additional efforts to educate the public about floodplain development, are necessary if damages due to flooding are to be minimized.

Flooding is one of the most significant natural hazards that regularly occurs in the state. All counties have flood preparedness plans which should improve response capabilities. However, sixty–one communities vulnerable to floods still have no local floodplain ordinances.

Figure 46

Presidential Flood Disaster Declarations, 1970–1990



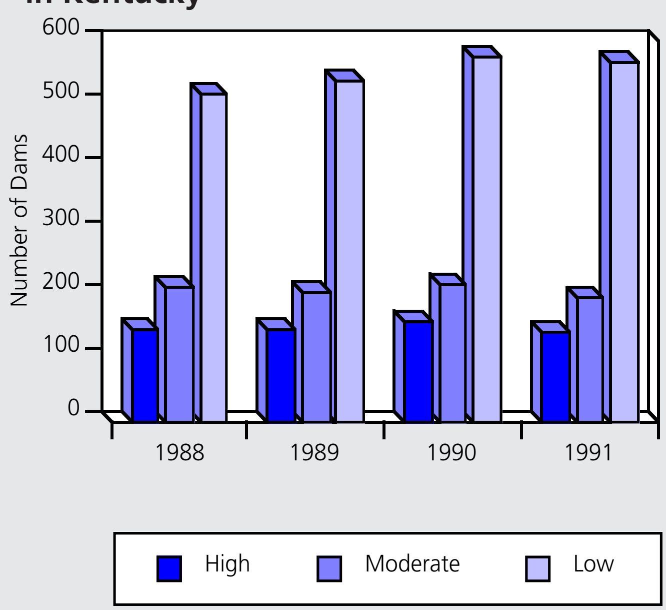
Source: Kentucky Disaster and Emergency Services, 1991

Dam Construction and Maintenance a Growing Public Safety Concern; 40% of 901 Inventoried Dams Classified as Moderate to High Hazard

There are 901 dams listed on the Division of Water's dam inventory. However, the Division estimates that there are at least 200 dams, as well as hundreds of mining–related impoundments under the jurisdiction of the Department for Surface Mining Reclamation and Enforcement, that are not included on the statewide inventory. Most of the 901 inventoried dams were not designed or constructed using currently acceptable engineering practices. Thirty-seven percent are classified as high or moderate hazard dams with the potential to cause loss of life or property damage should they fail **(Fig. 47)**. About 225 dam safety inspections are conducted by DOW every year. High and moderate hazard dams are inspected once every two to three years, and low hazard dams are inspected every five years.

These inspections reveal that many dams in Kentucky are unsafe. During the past two years, DOW has responded to 12 dam emergencies. As dams continue to age, threats from dam failures are expected to increase. Failure of surface mining impoundments and silt ponds are a particular concern. The failure of a surface mining impoundment in 1981 along Ages Creek in Harlan County was responsible for the only death in Kentucky caused by a dam collapse. This same failure caused millions of dollars in cleanup costs and litigation. Additional attention to inventorying dams and impoundments and ensuring their safety is urgently needed in Kentucky.

Figure 47
Dam Safety Hazard Classification Trends in Kentucky



Note: Earlier data not available.
Source: Kentucky Division of Water, 1992

There are 900 dams listed on the state's inventory. Most were not designed and constructed using currently acceptable engineering practices. Thirty-seven percent of the dams are classified as high or moderate hazard, with the potential to cause loss of life or property damage should they fail. During the last two years, 12 dam emergencies have occurred.

Kentucky River Locks in Poor Condition; Lawsuit Alleges Federal Agency Failed to Maintain Locks

There are 14 locks located along the Kentucky River. The deterioration of the locks has received a great deal of attention since Congress ordered the U.S. Army Corps of Engineers (COE) to transfer their ownership to the state. The locks were originally built in the 1800s to provide navigation of the Kentucky River for the transport of minerals, lumber, and other products from the eastern region of the state. Commercial navigation on the river has greatly declined over the years. Presently, Locks #1 through #4, which are operated by U.S. COE, are the only ones used by commercial traffic.

Recreational activity at the locks has remained fairly constant. More than 25,000 boats carrying nearly 110,000 passengers passed through Locks #5 through #14 between 1985 and 1991. Lock #10 at Boonesboro, and Lock #5 in Frankfort generally receive the greatest amount of recreational traffic.

The state has operated Locks #5 through #14 since 1985 under an agreement with U.S. COE. Lock #12 was closed during 1991 for safety reasons due to the deterioration of its metal gates. The lock will remain closed until funds can be found to make the necessary, and expensive repairs. The closing of this lock may ultimately result in the closing of Locks #13 and #14.

The costs associated with maintaining, operating, and upgrading the Kentucky River locks is very high. Since 1986, the state has expended $1.6 million for lock maintenance. Most of these funds were provided from boat registration receipts. In 1990, however, $385,000 was allocated from the state's General Fund for the upkeep of the locks. The Natural Resources and Environmental Protection Cabinet was allocated approximately $826,000 in state funds for fiscal years 1993 and 1994 to address the most critical needs and ensure that the locks can remain operational for recreation and water supply purposes.

The Kentucky River Authority, a nine–member board appointed in 1990 which is attached to the Cabinet, will oversee the locks when the U.S. COE transfers ownership. The Authority is studying water supply needs in the Kentucky River Basin and will administer any allocated funds for lock maintenance. The Authority is also seeking $9.5 million in federal appropriations to repair the Kentucky River locks and dams.

The state has filed two lawsuits against the U.S. COE for failure to adequately address problems associated with the Kentucky River locks. One suit is primarily concerned with navigational issues involving the integrity of lock walls, gate repair, and the maintenance of navigational channels. The other suit alleges that the U.S. COE has failed to comply with the provisions of the National Environmental Policy Act by not addressing the environmental impacts of their proposed abandonment of the locks. The suit also contends that the Corps failed to adequately assess the historic value of the 50 buildings associated with locks and dams.◆

Chapter 2

Air Quality

Air Quality

Air quality in Kentucky has improved dramatically during the last 20 years, primarily with regard to the "conventional" air pollutants in urban areas. Kentucky is achieving air quality standards for many of these air pollutants as a result of past control efforts. The most notable exceptions are Kentucky's failure to achieve ozone and sulfur dioxide air quality standards in some areas of the state.

While work must continue to achieve and maintain the standards for conventional air pollutants, additional problems which threaten public health and the environment must also be addressed. The 1990 amendments to the national Clean Air Act will begin to address the more complex air pollution issues of air toxics, global warming, stratospheric ozone depletion, and acid rain.

This chapter provides an overview of state and regional air quality trends, where available, and the steps necessary to maintain compliance with standards. National and global air pollution issues and Kentucky's role in confronting these important problems are reviewed. The increasing threats of indoor air pollution and their impacts in Kentucky are also discussed.

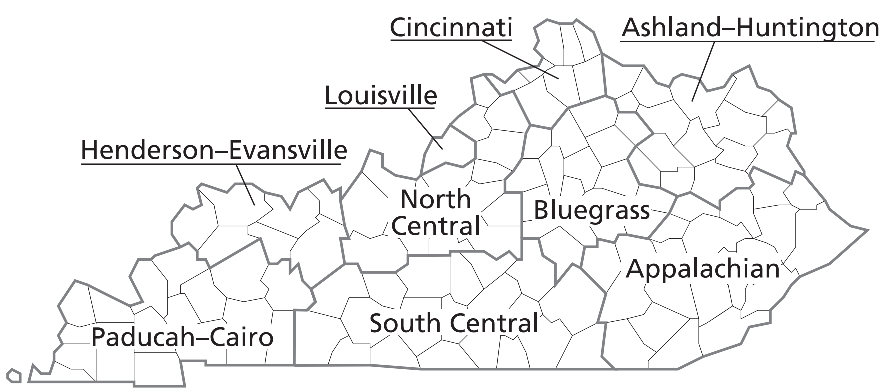
Determining Air Quality

3,000 Air Pollution Sources Regulated; 53 Monitors Provide Regional Trends for Air Quality

There are more than 3,000 regulated air pollution sources in Kentucky. Nearly 300 are considered major sources, emitting 100 tons or more of various air pollutants each year. It would be impossible to physically measure every source for all air pollutants. Instead, the state assesses air quality through the use of monitors, mathematical models, and various emissions testing methods.

The Kentucky Division for Air Quality (DAQ) operates a network of 53 monitoring stations across the state. These stations provide data used to determine compliance with standards for conventional air pollutants. The Environmental Quality Commission reviewed data from these monitors to develop yearly averages for air pollutants in the state's eight Air Quality Control Regions **(Fig. 1)**.

Figure 1
Air Quality Control Regions



Source: Kentucky Division for Air Quality, 1991

The Division for Air Quality oversees 53 air monitoring stations throughout the state. These monitors provide information on the quality of air and determine compliance with the national standards established to protect human health and welfare.

Emissions data from air pollution sources can also provide an overall view of air quality in Kentucky. Emissions can be determined through various methods including the following:

- Continuous emission monitors, which are placed in stacks of some sources to measure specific pollutants;
- Emission factors, as specified by the U.S. Environmental Protection Agency (EPA) and calculated by DAQ;
- Materials balance, which requires the source to account for chemicals used in processing; and
- Stack testing, to temporarily monitor emissions to determine compliance with limitations.

The limited statewide emissions data presented in this report is all that has been compiled by DAQ. The Division indicates it will attempt to assess statewide air emissions trends in the near future.

Conventional Air Pollutants

Data collected from the state's 53 air monitors were reviewed to assess regional ambient air quality for the conventional pollutants: ozone, nitrogen oxides, carbon monoxide, particulate matter, lead, and sulfur dioxide. It should be noted that year–to–year fluctuations in air quality for pollutants may occur as a result of pollution control efforts, climate conditions, industry closings, or temporary reductions in air emissions. However, since regional data have been evaluated in five–year intervals beginning with 1975, a general trend comparison for these pollutants can be made.

Ozone

Ozone, commonly called smog, is formed when emissions of volatile organic compounds and oxides of nitrogen from automobile exhaust, gasoline vapors, solvents, paints, and other pollutants react in the presence of sunlight. Groundlevel ozone is a pollutant and should not be confused with the ozone in the upper atmosphere which shields the earth from ultraviolet radiation. High levels of groundlevel ozone can cause or aggravate respiratory problems and stress the heart, especially in the elderly.

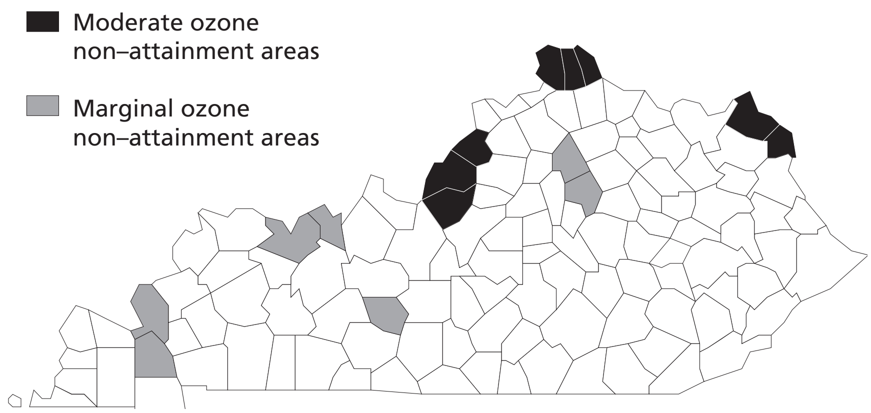
15 Counties Fail to Meet Ozone Standards

Ozone is the only one of the six criteria pollutants for which control strategies have failed to ensure that the health and welfare–based standards are achieved nationally and in Kentucky **(Fig. 2)**. Prior to the enactment of the 1990 Clean Air Act Amendments, five Kentucky counties were violating the ozone standard. They were: Boone, Boyd, Campbell, Jefferson, and Kenton counties. Based on monitoring data compiled for the years 1987 through 1989, ten additional Kentucky counties also violated the ozone standard. They were: Bullitt, Edmonson, Daviess, Fayette, Greenup, Hancock, Livingston, Marshall, Oldham, and Scott counties.

The average concentration of groundlevel ozone varies throughout the state. High ozone concentrations are most prevalent during the summer months when air is hot and stagnant. Prevailing winds can also carry ozone, or the pollutants that form ozone, far upwind of metropolitan areas. Therefore, ozone is more a geographical problem than the other conventional pollutants.

Figure 2

Counties with Ozone Air Pollution Problems



Note: In Greenup, Bullitt, Oldham, Hancock and Livingston counties only a portion of the county is nonattainment.

Source: Kentucky Division for Air Quality, 1992

Groundlevel ozone, or smog, is formed when emissions from vehicles, industries, and other sources react in the presence of sunlight. Ozone is the only one of six "conventional" air pollutants for which control strategies have failed to achieve standards both nationally and in 15 Kentucky counties.

Ozone Levels Highest in State During 1980, 1983, and 1988; Associated with Weather Conditions

Sparsely populated areas with low industrial emissions generally achieve ozone standards. Nearly all attainment problems occur in metropolitan areas, such as Louisville and Northern Kentucky, or in rural areas which have high industrial emissions of volatile organic compounds (VOCs) or nitrogen oxides, such as Boyd and Marshall counties.

Ozone standards were exceeded most often in 1980, 1983, and 1988, both nationally and in Kentucky **(Figs. 3 and 4)**. DAQ attributes excessive ozone formation during these years to weather conditions. A general overview of monitoring data reveals that ozone levels in 1990 were higher in four regions and lower in three compared to 1975 levels **(Fig. 5)**.

Average ozone levels in Jefferson, Boone, Campbell, Kenton, and Boyd counties exceeded the standard in 1991. The U.S. EPA classifies these five counties, as well as portions of Bullitt, Greenup, and Oldham counties, as "moderate nonattainment," meaning that they must institute measures to achieve reductions in ozone.

Seven additional counties: Edmonson, Daviess, Fayette, Hancock, Livingston, Marshall, and Scott; were classified as "marginal nonattainment" by the U.S. EPA, in January 1992. These counties are subject to less stringent ozone reduction requirements, but must meet the standard by 1996 or be reclassified to moderate nonattainment and subjected to stricter emissions controls. State officials plan to request the U.S. EPA to reclassify these seven marginal counties to "attainment" since no exceedences of ozone standards have occurred since 1989.

Figure 3

Number of Days* Ozone Standards were Exceeded by Region

Year	Bluegrass	N. Ky. Cincinnati	Henderson Evansville	Ashland Huntington	Louisville	Paducah Cairo	N. Central	Statewide Average**
1985	0.4	2.4	0.7	4.8	11.0	0.3	1.0	2.9
1986	2.1	0.7	0.7	3.1	4.1	0.7	1.0	1.8
1987	1.6	1.0	0.7	3.8	1.8	0.7	1.0	1.4
1988	2.7	5.4	4.1	6.2	4.5	4.0	4.3	4.5
1989	2.0	5.4	3.7	5.5	7.2	2.0	3.2	4.1
1990	2.0	4.7	4.4	5.3	6.0	1.3	3.9	3.9
Total	**11**	**20**	**14**	**29**	**35**	**9**	**14**	**19**

**Based on expected number of days standards were violated.*

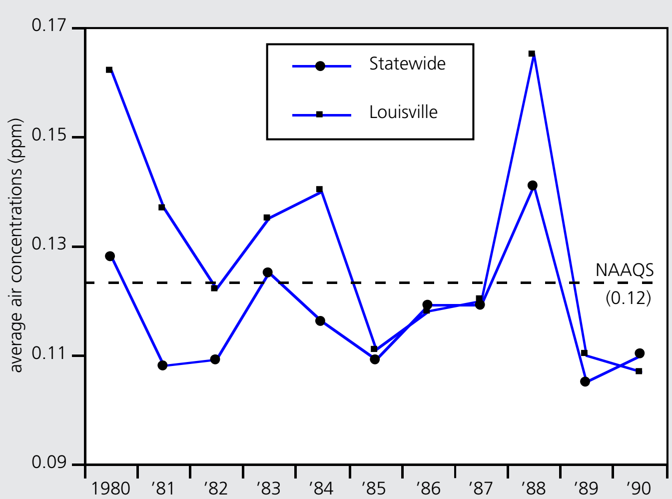
***The statewide average does not include the South Central and Appalachian Regions because consistent data were not available.*

Source: Kentucky Division for Air Quality monitoring data, 1991

High ozone levels can cause or aggravate respiratory problems and stress the heart, especially in older people. The number of days in which ozone standards are violated appears to be increasing in most regions of the state.

Figure 4

Statewide Averages for Ozone

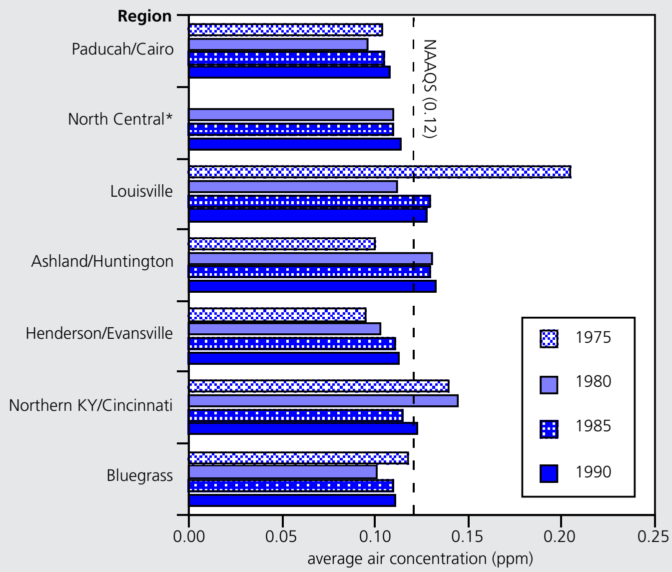


Note: Based on 2nd maximum 1 hour average. Compared to National Ambient Air Quality Standards (NAAQS) for ozone.

Source: Kentucky Division for Air Quality monitoring data, 1991

Violations of the ozone standard were most common in 1980, 1983, and 1988 due to hot and stagnant weather conditions. Ozone levels in the Louisville Metropolitan area are typically higher than the average in other regions as a result of relatively high vehicle and industrial emissions associated with ozone problems.

Figure 5
Average Air Concentration of Ozone in Kentucky



Note: Based on 2nd maximum one hour average. Data compares the 1975 National Ambient Air Quality Standard (NAAQS) for ozone which was 0.08 ppm. The standard was made less stringent in the late 1970s.

** 1975 data for the N. Central Region was unavailable.*

Source: Kentucky Division for Air Quality monitoring data, 1991

No significant trends are apparent for ozone pollution in Kentucky. Ozone problems do occur more often in areas that are densely populated, or those rural areas with high industrial emissions such as Louisville, Northern Kentucky, and Boyd county.

Picture of traffic

Reduction in Emissions from Vehicles and Other Sources Assist in Reducing Ozone

Reducing the emissions of VOCs, carbon monoxide, and oxides of nitrogen can inhibit the formation of ozone. Early regulatory efforts in the 1970s were centered on reducing these emissions from industrial sources. In the late 1970s and early 1980s, emissions from dry cleaners and automobile exhaust, as well as vapors released during the filling of underground gasoline storage tanks, were addressed. The relative contribution of these emission sources to the ozone problem varies in the state's ozone nonattainment areas.

In Jefferson County, VOC emissions were reduced 69% between 1980 and 1988. During that period, emissions were reduced 63% in Boyd County but remained about the same in Northern Kentucky **(Fig. 6 and 7)**.

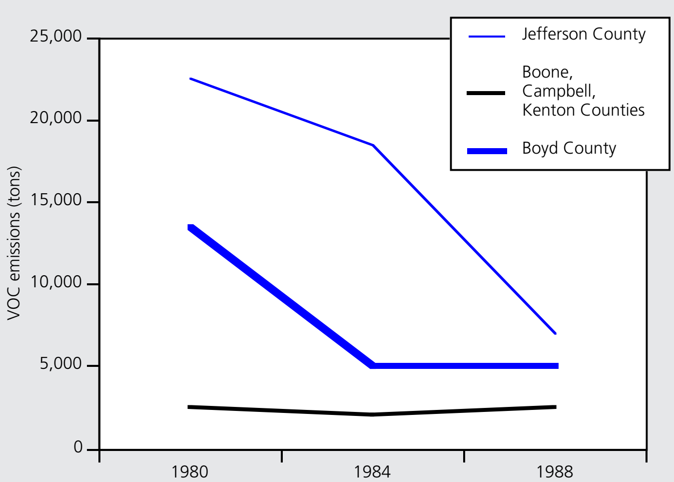
These reductions were still not enough to achieve compliance with the ozone standards. The eight counties in Kentucky designated as moderate nonattainment will be required to install additional controls at gas pumps to recover vapors. New vehicle emission testing (VET) programs will be required in Boyd, Boone, Campbell, and Kenton counties. The state will operate the VET program in Northern Kentucky, which is scheduled to be implemented in 1993. The current automobile exhaust testing program in Jefferson County will need to be modified to meet additional requirements. The Clean Air Act Amendments require these moderate nonattainment areas to achieve an additional 15% reduction in VOC emissions by 1996.

Industrial Sources Emit 34 Million Pounds of Ozone–Forming Chemicals in 1990; Most Released in Jefferson, Boyd, and Marshall Counties

Approximately 34 million pounds of VOCs were reported released into the air in Kentucky during 1990, compared to 37 million pounds in 1989. The majority of these emissions were released in ozone nonattainment areas, primarily Jefferson, Boyd, and Marshall counties. It is important to note that these emissions do not include all VOC releases. Many small, as well as large, emission sources are not required to report to the state.

VOC emissions were estimated by the U.S. EPA to be higher in the Southeastern United States, including Kentucky, than any other region in the nation during 1989. Regional data suggest a 19% decrease in emissions between 1980 and 1989. VOC

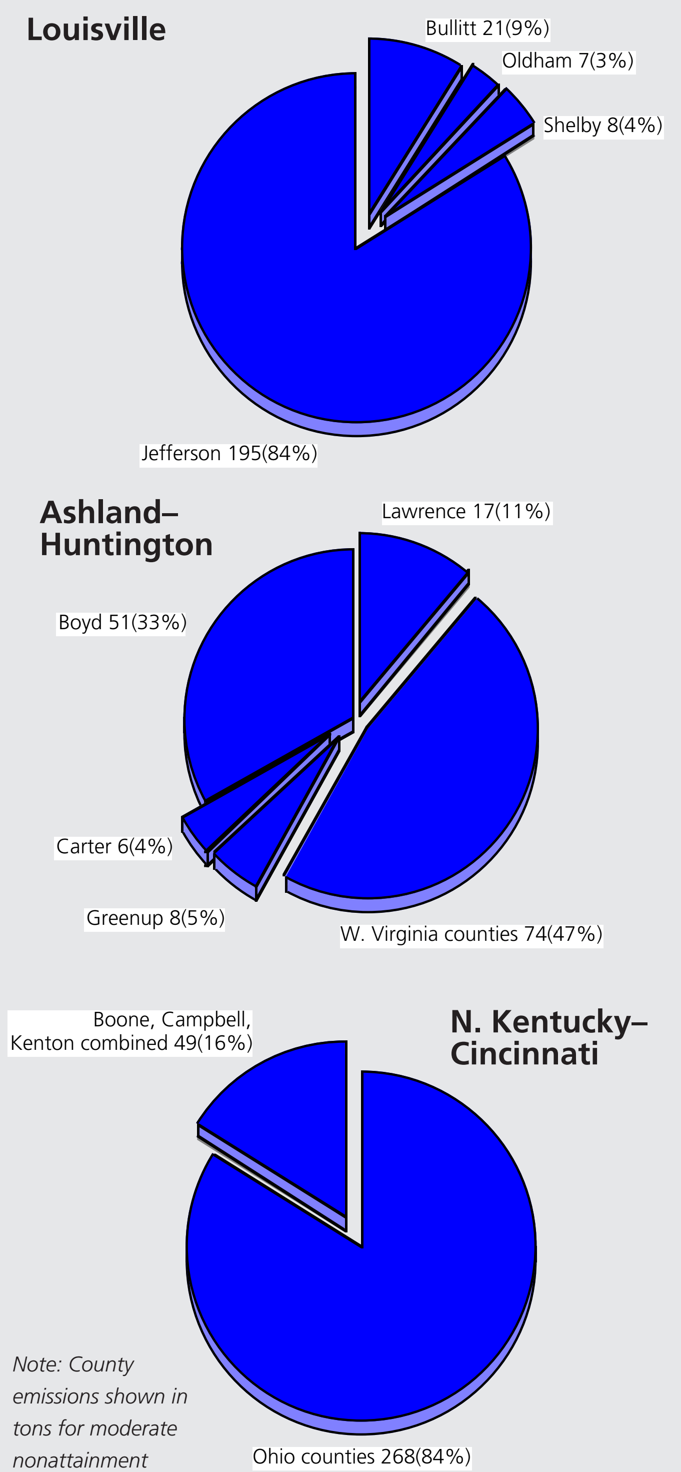
Figure 6
Volatile Organic Compound Emissions in State Ozone Nonattainment Areas



Note: Emissions shown for moderate ozone nonattainment areas in Kentucky, includes only stationary sources (industries), data estimated.
Source: Kentucky Division for Air Quality monitoring data, 1992

Volatile organic compound emissions are associated with the formation of ozone. Industrial VOC emissions in Jefferson and Boyd counties declined significantly during the 1980s due to emission control efforts and economic factors. Industrial emissions in the Northern Kentucky counties were not reduced noticeably.

Figure 7
Volatile Organic Compound Emissions in State Ozone Nonattainment Areas



Note: County emissions shown in tons for moderate nonattainment areas in Kentucky, 1988 data.

Source: Kentucky Division for Air Quality, 1992

Volatile organic compound (VOC) emissions from neighboring states greatly contribute to ozone pollution problems in the Northern Kentucky and Ashland areas. The 1990 Clean Air Act Amendments will require these areas and Jefferson County to reduce VOC emissions to achieve compliance. New vehicle exhaust testing programs will be required in Northern Kentucky and Boyd County. Additional vehicle testing requirements will also be initiated in Jefferson County.

emissions from motor vehicles are estimated to have declined 34% during that period, representing the greatest decline of any source. However, it is predicted that the increasing number of vehicle miles traveled, an expanding population, and economic growth will offset much of the VOC reductions achieved by control programs.

The 1990 Clean Air Act Amendments will require Kentucky and other states to thoroughly evaluate VOC emissions from industrial transportation, and area sources, such as dry cleaners, paint shops, and service stations, in areas failing to meet the ozone standards. The U.S. EPA is requiring some highly volatile products, such as fuels and solvents, to be reformulated to reduce VOCs emitted during their use. Achieving the mandated 15% reduction in VOC emissions in the state's ozone nonattainment areas by 1996 will be particularly challenging because many of the relatively "easy" reductions have already been accomplished through earlier controls.

Nitrogen Oxides

Nitrogen Dioxide Standards Achieved in Kentucky, But Levels Increasing in Three of Six Regions

Nitrogen oxides (NOx) are produced when fossil fuels are burned by coal–fired power plants, industries, and motor vehicles. Standards limiting the amount of nitrogen dioxide (NO_2) allowed in the air were established because high concentrations are known to damage human health. Nitrogen oxides also combine with water to form an acid and contribute to the formation of acid rain and ozone pollution.

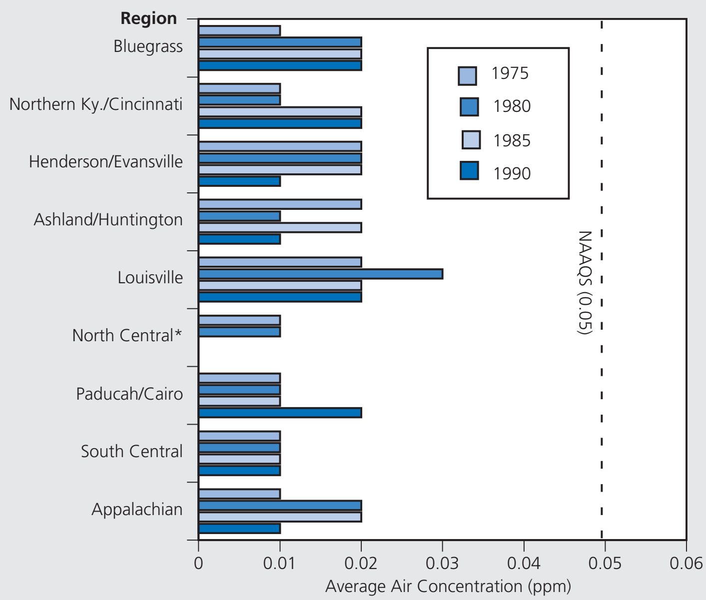
All regions of the state currently meet the air quality standards for NO_2 **(Fig. 8 and 9)**. No areas have failed to attain the standards in the past. Regional data show, however, that average air concentrations of NO_2 were greater in 1990 than in 1975 in three of the state's six regions. Two of the six regions had lower average concentrations during that period.

Statewide Nitrogen Oxide Emissions Decline Slightly; More Sources May Offset Gains

Statewide NOx emissions from sources such as power plants and industries varied during the early 1980s, according to DAQ. Technological improvements that were employed to reduce emissions from industrial boilers likely resulted in a slight decline in emissions. These reductions leveled off during the late 1980s as the improvements achieved by earlier control strategies peaked.

NOx emissions from automobiles and many chemical processes are being better controlled by the use of catalytic converters. However, there is concern that gains achieved by emission controls will be offset by the increased number of emission sources. Strategies are being developed for reducing NOx emissions from vehicles and stationary sources in communities which fail to attain ozone standards, although the Clean Air Act Amendments do not specifically require major NOx reductions. The U.S. EPA is required to establish NOx emission limits for electric power generators and non–utility boilers by 1994. Emissions data reported by the U.S. EPA indicate no significant nationwide increases or decreases in NOx emissions between 1980 and 1989 by major sources.

Figure 8
Regional Air Concentrations of Nitrogen Dioxide in Kentucky

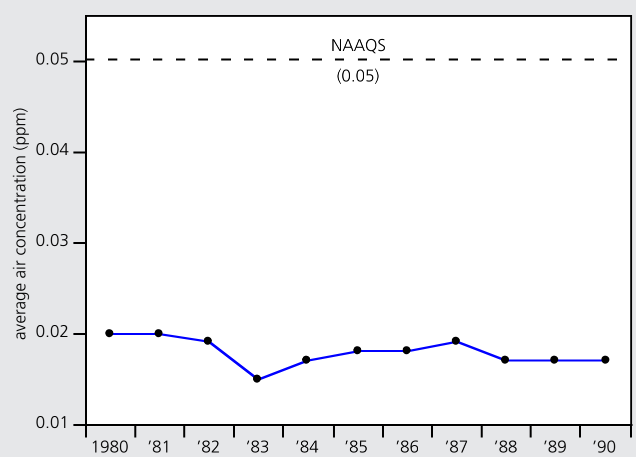


Note: Values were rounded to the nearest one–hundredth. Compared to National Ambient Air Quality Standards (NAAQS) for nitrogen dioxide.
** N. Central Region not monitored in 1985-1990*
Source: Kentucky Division for Air Quality monitoring data, 1991

All regions of Kentucky have consistently achieved the air quality standards for nitrogen dioxide. Regional data indicate, however, that average concentrations were greater in 1990 than 1975 in three of the state's nine regions, and lower in two.

The slight overall decline in statewide levels of nitrogen dioxide in the air may have been the result of pollution control devices used for industrial boilers and automobiles. There is concern that gains achieved by these and other controls may be offset by the increasing number of emission sources.

Figure 9
Statewide Averages for Nitrogen Dioxide in Kentucky



Note: Based on annual statewide average. Compared to National Ambient Air Quality Standard (NAAQS) for nitrogen dioxide.
Source: Kentucky Division for Air Quality monitoring data, 1991

Carbon Monoxide

State Meeting Carbon Monoxide Standards; Levels Declining in Most Regions

Carbon monoxide (CO) is a poisonous gas formed when fossil fuels such as gasoline and coal are burned and fail to combust completely. Carbon monoxide may cause many serious health problems, including dizziness and slowed reflexes, when standards are exceeded. Very high concentrations can lead to death.

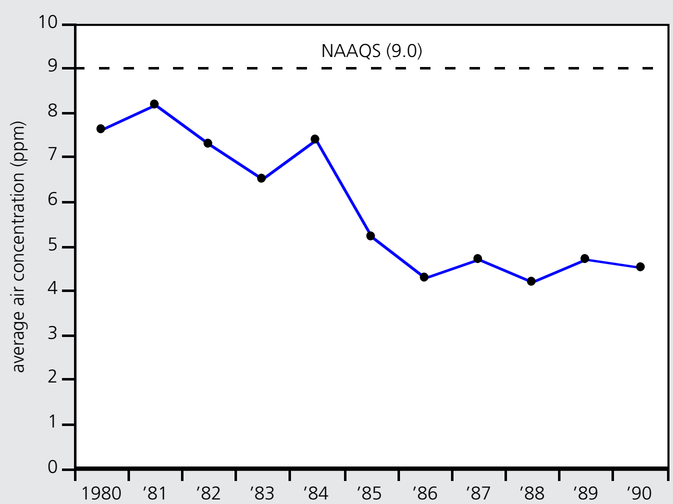
The only area in Kentucky which has experienced problems meeting air quality standards for carbon monoxide is Jefferson County. However, the implementation of a vehicle inspection and maintenance program in 1984 reduced CO emissions in that area. Present CO emissions in Jefferson County are reported to be significantly less than those in 1980. The area is now in compliance with carbon monoxide standards.

Because vehicular emissions are reported to be responsible for 97% of the carbon monoxide releases, the federal government required all vehicles built since 1974 to be equipped with improved emissions controls. This has resulted in national and statewide reductions in CO. Five of the six regions in the state with carbon monoxide monitoring had significant, steady decreases in the amount of carbon monoxide measured in the air between 1975 and 1990 **(Fig. 10 and 11)**.

National reports show a 23% nationwide decrease in CO emissions between 1980 and 1989. Most of the reductions occurred in the transportation sector where a 33% decrease in CO emissions was achieved during this nine–year period, even though the average number of individual automobile miles traveled increased by 39%.

Further CO emission reductions are expected to be achieved in areas not attaining ozone standards, since controls used to reduce nitrogen oxides and other ozone–related pollutants also limit carbon monoxide emissions.

Figure 10
Statewide Averages for Carbon Monoxide in Kentucky

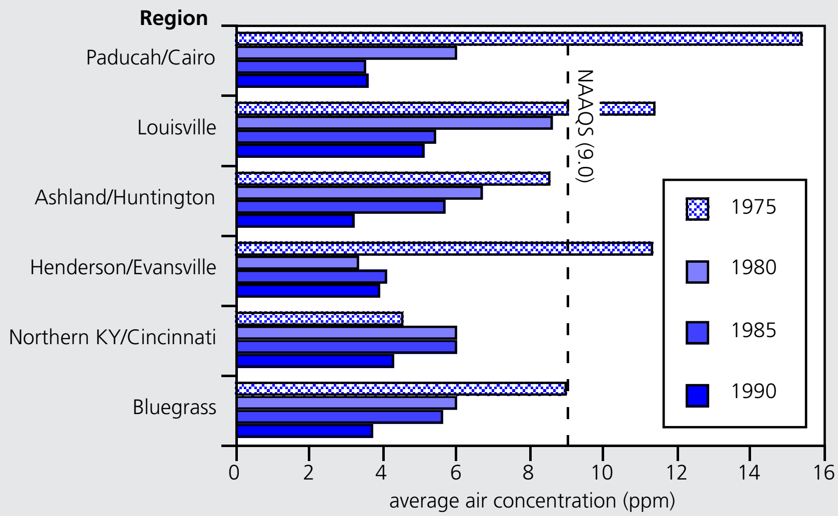


Note: Based on the 2nd maximum 8 hour average. Compared to National Ambient Air Quality Standard (NAAQS) for carbon monoxide.

Source: Kentucky Division for Air Quality monitoring data, 1991

Carbon monoxide levels in the air declined about 40% statewide from 1980 through 1990. This is largely attributed to the federal requirement that all new vehicles built since 1974 be equipped with pollution control devices.

Figure 11
Regional Air Concentrations of Carbon Monoxide in Kentucky



Note: Based on 8 hour average–2nd max. Compared to National Ambient Air Quality Standard (NAAQS) for carbon monoxide.

Source: Kentucky Division for Air Quality monitoring data, 1991

All Kentucky regions now achieve the carbon monoxide standard. Levels have declined steadily in five of the six monitored regions.

Particulate Matter

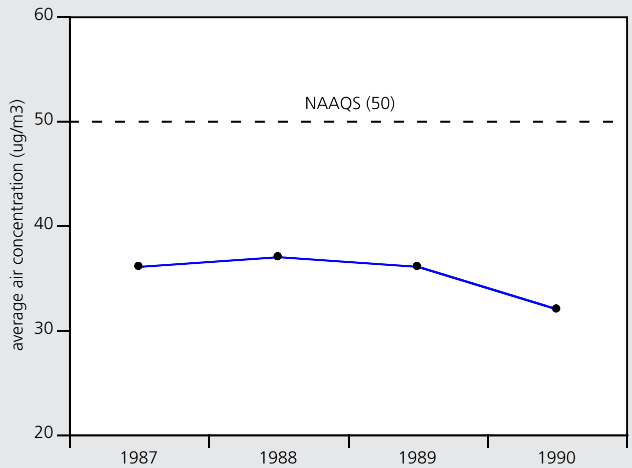
All Regions of State in Compliance with Particulate Standards

The health–based standard for airborne particulates is presently being achieved in all of the state's monitored air quality control regions. Until 1987, the standard was based on the total amount of particulates suspended in the air (TSP). Several Kentucky counties failed to achieve the TSP standard. The current standard, known as PM_{10}, requires that smaller particulates (those less than 10 microns in diameter), which are more directly associated with adverse health effects, be monitored and controlled. Smaller particles are recognized as causing the greatest health threats because when inhaled they can become imbedded in the lungs. There have not been any recorded violations of the new PM_{10} standard in Kentucky **(Fig. 12 and 13)**.

Regional Particulate Levels in Kentucky Vary Due to Many Factors

Small airborne particulates, such as dust and soot, come from many sources. These pollutants are emitted by industrial sources, construction activities, mining, crushing, and combustion of fuels in boilers and furnaces. Other sources of particulate matter include agricultural activities, construction site preparation, and unpaved roads. Open burning also releases particulate matter into the air. During 1990, DAQ received 346 complaints of open burning, many of which involved tires.

Figure 12
Statewide Averages for Particulates (PM_{10}) in Kentucky

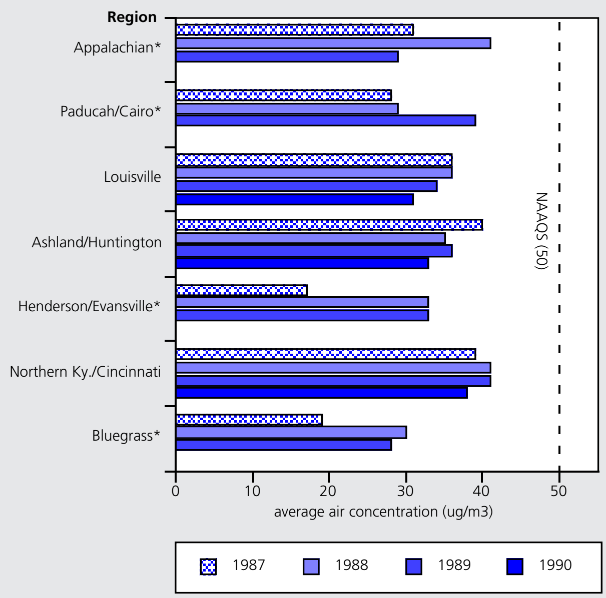


Note: Based on annual average. Compared to National Ambient Air Quality Standard (NAAQS) for Particulates (PM_{10}).
Source: Kentucky Division for Air Quality monitoring data, 1991

The particulate standard was changed in 1987 from the total amount of suspended particulates in the air, to the PM_{10} standard which controls more directly the small particles associated with adverse health effects.

No violations of the new particulate standard have been reported in Kentucky, although several regions failed to achieve the earlier total suspended particulates standard.

Figure 13
Regional Concentrations of Particulates (PM_{10}) in Kentucky



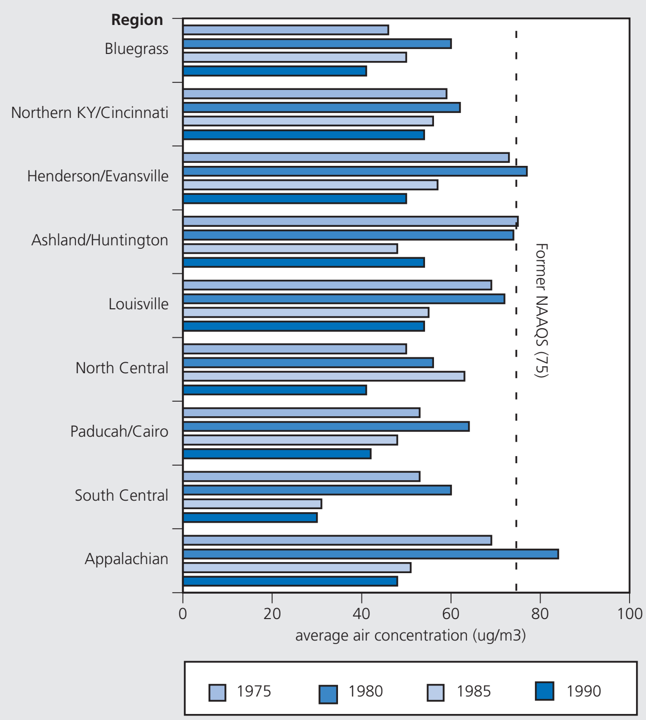
**Monitoring not conducted in 1990.*
Note: compared to National Ambient Air Quality Standard (NAAQS) for particulates (PM_{10}).
Source: Kentucky Division for Air Quality monitoring data, 1991

Monitoring data shows that all nine regions had lower average TSP levels in 1990 than in 1975 **(Fig. 14)**. Particulate levels were highest during 1988. This was attributed, at least in part, to the unusually hot and dry weather that year. The decreases which occurred in most regions were not the result of any additional control strategies, according to DAQ. National TSP emission trends show a 15% decline between 1980 and 1989.

The shift in monitoring and control strategies from TSP to PM10 may reduce the health threats associated with high concentrations of airborne particulates. Reducing emissions of air toxics, which can adhere to small particles, may also assist in reducing health risks from particulates.

The amount of total suspended particulates in the air is closely linked to dry weather conditions and land disturbance activities. Several regions experienced problems achieving the TSP standards, although annual regional averages do not demonstrate this clearly.

Figure 14
Regional Air Concentrations of Total Suspended Particulates in Kentucky



Note: 1980 data for Appalachian Region may be elevated due to an unusually high reading at one station.
1990 data based on arithmetic mean—other years are geometric. Compared to National Ambient Air Quality Standards (NAAQS) for Total Suspended Particulates. This standard was replaced with PM_{10}.

Source: Kentucky Division for Air Quality monitoring data, 1991

Lead

Lead Levels in Air Reduced Dramatically in Many Regions of the State

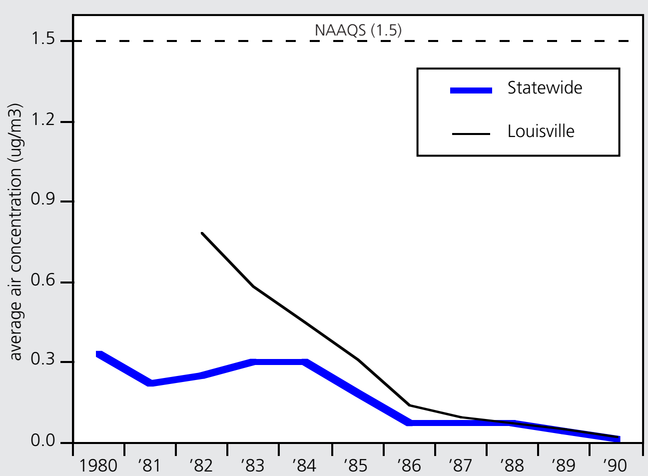
Kentucky has consistently achieved national air quality standards for lead in all regions of the state **(Fig. 15)**. Lead levels in the air were significantly higher statewide in 1980 than those recorded during 1990.

The Louisville Region has historically had the highest average lead concentrations in the state. Lead levels in that area averaged 0.97 ug/m3 in 1980, notably higher than the national average of approximately 0.6 ug/m3 for urban areas. By 1990, lead levels in Louisville had declined 99% to an average concentration of 0.01 ug/m3, which was representative of typical urban areas in the U.S. However, background lead levels in the soil in many areas of the city have been shown to exceed safe levels.

Declines in ambient lead levels were also recorded during this same period for the Henderson–Evansville area (94%) and the Ashland–Huntington Region (91%). The Northern Kentucky Region experienced less of a decline (68%) between 1980 and 1989, although the reduction was still significant **(Fig. 16)**.

Monitoring for lead is no longer being conducted in most regions of the state because of the phase-out of leaded gas and the subsequent drop in ambient air levels. However, monitoring is ongoing in Greenup County near the Armco Steel facility and at two sites in Jefferson County. None of these areas currently violate the lead standard. The U.S. EPA now requires monitoring at specific point sources, rather than near transportation routes as in earlier years.

Figure 15
Statewide* Average Air Concentrations of Lead in Kentucky

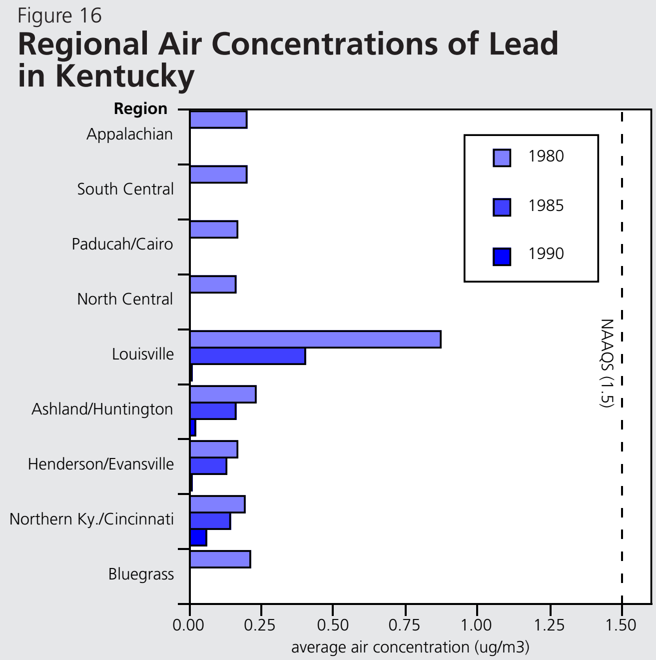


Note: Based on yearly mean. Compared to National Ambient Air Quality Standard (NAAQS) for Lead.

**After 1980 most state lead monitoring was limited to a few industrial sites. Statewide averages were based on all available data.*

Source: Kentucky Division for Air Quality monitoring data, 1992

There has been a dramatic decline in lead levels in the air, both in Kentucky and nationally, due to the phase–out of leaded gasoline. This represents important progress in reducing the public's exposure to this harmful pollutant.



Note: 1975 data not available for all regions. Several regions had no lead monitoring in 1985 and 1990. Compared to National Ambient Air Quality Standards (NAAQS) for lead.
Source: Kentucky Division for Air Quality monitoring data, 1991

State regions with continuous monitoring show steady decreases in lead levels. Monitoring is no longer routinely conducted in most regions, but is focused on a few industrial facilities, none of which report violations.

Lead Emissions from Vehicles Decline Dramatically Due to Phase-Out of Leaded Gasoline

The decreasing trend in lead levels in the air is due largely to the phase-out of leaded gasoline during the 1970s and 1980s. Unleaded gasoline was introduced in 1975, and by 1989, 89% of all gasoline sold nationwide was unleaded. Between 1980 and 1989, lead emissions decreased nationally by 90%. Lead emissions from the transportation sector declined 96% during this period. In 1985, 73% of all lead emissions came from transportation activities; by 1989, this figure had dropped to 31%. Reliable statewide lead emissions data for Kentucky are not available from DAQ. However, the decreased lead levels recorded for many regions would indicate that the national trends reported are generally true for Kentucky also.

Emissions of lead from some manufacturing industries have been reported to the state since 1987. In 1990, these industries reported releasing 36,662 pounds of lead and lead compounds into the air in Kentucky compared to 43,688 pounds in 1989.

The overall decline in lead emissions and ambient air concentrations both nationally and in Kentucky represents important progress in reducing public exposure to lead.

Sulfur Dioxide

All Regions in Kentucky Are Meeting Sulfur Dioxide Standard, with Exception of Boyd County

Sulfur dioxide (SO_2) is a pungent, colorless gas that complicates respiratory diseases, irritates eyes, injures aquatic life, and is linked to the formation of acid rain. All areas of the state are presently attaining the primary air quality standard for SO_2, with the exception of a portion of Boyd County near Catlettsburg. Muhlenberg County has been classified as a nonattainment area for SO_2, although the standard is currently being achieved. DAQ reports that this area will likely be reclassified as attainment by 1994.

Boyd County will not be reclassified to attainment status until emissions limits are recalculated for the Ashland Oil facility located near Catlettsburg. The U.S. EPA indicates that Ashland Oil's emissions are based on stack heights that are too high, which allows greater emissions than the U.S. EPA considers acceptable. Reclassification of the area is also dependent upon violations of the SO_2 standard documented in nearby West Virginia.

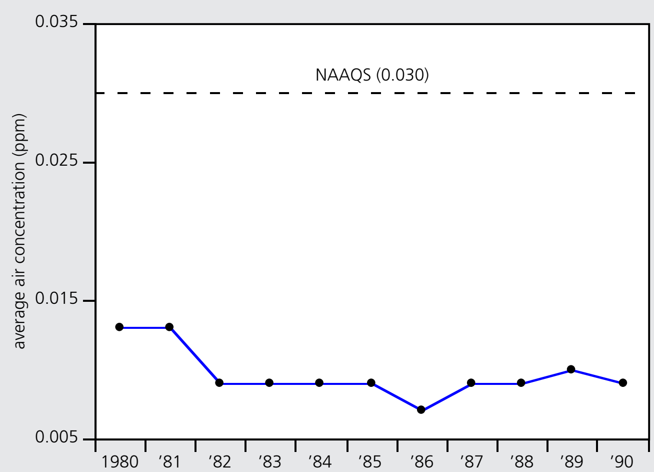
Since the late 1970s, the number of areas not attaining the SO_2 standard has been reduced from seven to one. The seven areas failing to achieve the standard in the 1970s were: Jefferson, Webster, Muhlenberg, Boyd, and McCracken counties, and the cities of Owensboro and Henderson.

SO_2 Emissions Increase in Bluegrass, Ashland Regions; Decline in Louisville and Paducah

Statewide, the average regional air concentrations of SO_2 have generally been well below the primary national air quality standard for selected years during 1975 through 1990 **(Fig. 17 and 18)**. The attainment problems experienced in Boyd County are not clearly reflected in Fig. 18 because regional averages are shown rather than site specific data.

Although the SO_2 standard is generally being achieved throughout the state, several regions appear to have had higher average daily concentrations of sulfur dioxide in 1990, compared to levels recorded in 1975. In 1990, SO_2 concentrations were 38% higher than 1975 levels in the Bluegrass Region, 28% higher in the Northern Kentucky–Cincinnati

Figure 17
Statewide Sulfur Dioxide Averages in Kentucky



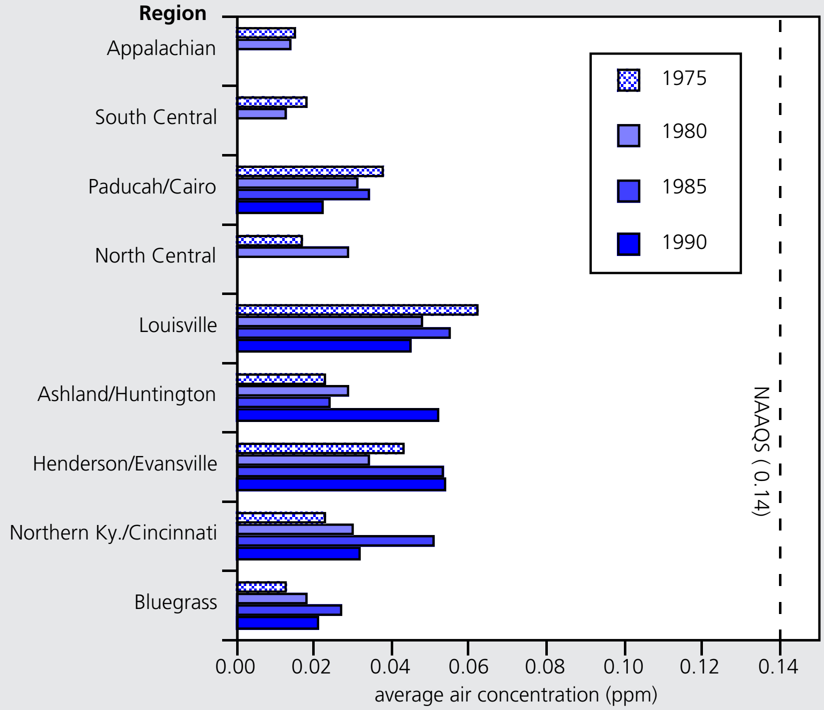
Note: Based on annual averages. Compared to National Ambient Air Quality Standards (NAAQS) for sulfur dioxide.
Source: Kentucky Division for Air Quality monitoring data, 1992

The average concentration of sulfur dioxide in the air declined during the 1980s and has remained well below the standard in most of the state.

The state experienced problems achieving the sulfur dioxide standard in seven areas during the 1970s. Reduced emissions from coal–fired power plants have resulted in better compliance in most areas. However, sulfur dioxide concentrations are increasing in some regions of the state.

Figure 18

Regional Air Concentrations of Sulfur Dioxide in Kentucky



Note: 24 hour averages 2nd maximum. Three regions had no SO_2 monitoring in 1985 and 1990. Compared to National Ambient Air Quality Standards (NAAQS) for sulfur dioxide.

Source: Kentucky Division for Air Quality monitoring data, 1991

Region, 20% higher in the Henderson–Evansville Region, and 56% higher in the Ashland–Huntington Region. DAQ indicates that this was not unexpected since additional regulatory requirements were not imposed to achieve SO_2 emissions reductions. SO_2 levels in the Louisville and Paducah–Cairo regions declined by 37% and 42%, respectively, during the same time frame. Reductions in SO_2 emissions from area coal–fired power plants are largely responsible for these decreases.

The major source of SO_2 emissions in Kentucky is coal–fired power plants. These sources alone account for 85% to 90% of all statewide SO_2 emissions **(Fig. 19)**. Controls imposed on emissions from these plants, and the use of new technologies such as fluidized bed combustion, have combined to result in overall reductions in statewide SO_2 emissions over the years.

SO_2 emissions from coal–fired utilities operating in Kentucky decreased from 1.3 million tons in 1976 to 675,000 tons in 1990, a 48% decline. Most of these reductions occurred during the early and mid–1980s. The greatest reductions were achieved at the Tennessee Valley Authority power plants located in McCracken and Muhlenberg counties **(Figs. 20 and 21)**. Nationally, $S0_2$ emissions were reduced approximately 10% during the same period.

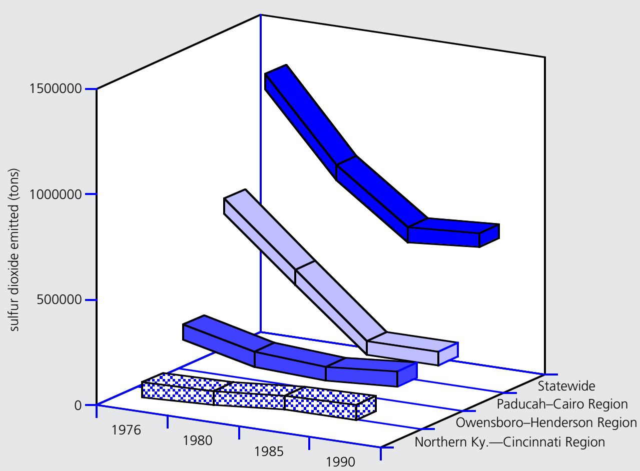
Figure 19
Coal–Fired Power Plants in Kentucky

Company	Number of Stations	Total Units	Number of Scrubbed Units
Big Rivers	4	9	3
East Kentucky Power	3	8	1
Cincinnati Gas & Electric	1	1	1
Henderson Mun. Power	1	2	0
Kentucky Power	1	2	0
Owensboro Mun. Util.	1	2	0
Kentucky Utilities	5	13	2
Louisville Gas & Electric	3	8	8
Tennessee Valley Auth.	2	13	2
Total	**21**	**58**	**17**

Source: Kentucky Division for Air Quality; Louisville Gas & Electric, 1992

Coal–fired power plants release 85–90% of all statewide sulfur dioxide emissions. Seventeen of the state's 58 plants have installed scrubbers to control emissions.

Figure 20
Sulfur Dioxide Emissions from Coal–fired Power Plants for Selected Kentucky Regions



Source: Kentucky Division for Air Quality monitoring data, 1991

Controls on power plant emissions and the use of new technologies have resulted in reductions of SO_2 emissions. Overall, these emissions declined 48% between 1976 and 1990 in Kentucky.

Figure 21
Sulfur Dioxide Emissions (tons) from Kentucky Coal–fired Power Plants

County	Facility	1976	1990
McCracken	TVA-Shawnee	288,000	47,000
Muhlenburg	Kentucky Utilities-Green River	27,000	16,000
Muhlenburg	TVA-Paradise	456,000	137,000
Ohio	Big Rivers Electric-Wilson	0	8,552
Daviess	OMU Elmer Smith	74,000	51,000
Hancock	Big Rivers Electric-Coleman	100,000	71,000
Henderson	Henderson Mun. Power & Light	9,000	1,000
Webster	Big Rivers Electric-Reid	81,000	49,000
Webster	Big Rivers Electric-Green	0	11,000
Boone	Cincinnati Gas & Electric	0	20,000
Carroll	Kentucky Utilities-Ghent	76,000	101,000
Bell	Kentucky Utilities-Pineville	1,000	300
Clark	E. Ky. Rural Electric-Dale	8,000	3,000
Fayette	Kentucky Utilities*	5	5
Mercer	Kentucky Utilities-Brown Station	57,000	56,000
Woodford	Kentucky Utilities-Tyrone	2,000	1,000
Lawrence	Ky. Power-Big Sandy	60,000	51,000
Mason	E. KY. Power Co.-Spurlock	0	31,000
Pulaski	E. KY. Power Co.-Cooper	35,000	18,000
Jefferson	LG&E-Mill Creek	112,039	26,625
Jefferson	LG&E-Cane Run	109,578	12,163
Statewide		**1,496,417**	**713,388**

Note: Figures shown may not equal totals because they were rounded to the nearest ton.

**Not coal-fired.*

Source: Kentucky Division for Air Quality, 1992 and Jefferson County Air Pollution Control District

Most coal-fired power plants in Kentucky have reduced SO_2 emissions. The greatest reductions occurred at the TVA McCracken and Muhlenberg plants.

Air Toxics

Controlling toxic air pollutants has only recently been required at the national level through the 1990 amendments to the Clean Air Act. While Kentucky began regulating air toxics in 1986, the effectiveness of state regulations to control these emissions at levels needed to ensure adequate public protection has been in question.

Eight Counties Had Toxic Air Emissions Greater Than 1 Million Pounds in 1990

Nearly 53% of the 78.8 million pounds of toxic releases reported by Kentucky manufacturers during 1990 were released into the air **(Fig 22)**. More than 41 million pounds of toxic chemicals were released into the air by 400 reporting industries, compared to 47.2 million pounds emitted by 322 facilities in 1988.

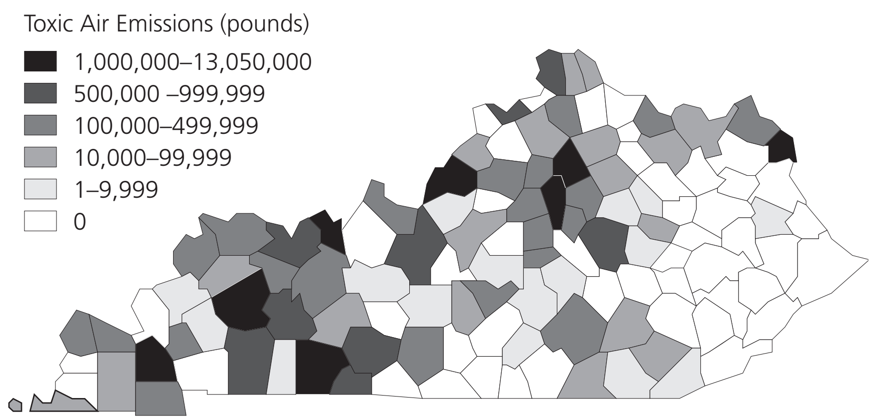
Industrialized counties such as Jefferson, Marshall, and Hancock, receive a large proportion of the air toxics released in Kentucky **(Fig. 23)**. In 1990, eight counties had toxic air emissions greater than 1 million pounds, compared to seven counties in 1989. Thirty–nine Kentucky counties had air toxic emissions greater than 100,000 pounds, and 33 had between one and 100,000 pounds reported released in 1990.

Approximately 72% of all toxics released to the air were legally permitted stack emissions, although this is not an indication that exposure to these chemicals is risk free. The other 28% were "fugitive" emissions that were released through leaks, spills, or otherwise escaped. Fugitive emissions are not specifically addressed in the air quality control permits. It is difficult to accurately compare air toxic emissions data year–to–year because reporting requirements are relatively new and evolving, and most importantly, because the addition or closure of a single facility can greatly change the year's total emissions.

More than 41 million pounds of toxic chemicals were released into Kentucky's air from manufacturing industries during 1990. The full health and environmental impacts of these releases are generally unknown.

Figure 22

Toxic Air Emissions from Reporting Industries (1990)



Source: Kentucky Department for Environmental Protection Toxic Chemical Release Inventory Data, 1990

Ten counties in Kentucky receive nearly 75% of the statewide toxic air releases. Reported emissions in these counties declined 11% between 1988 and 1990.

Figure 23

Toxic Air Emissions in Kentucky (top 10 counties)

County	Toxic Releases (pounds) 1988	1989	1990	% Change between 1988–1990
Jefferson	11,924,548	13,048,699	11,772,219	–1
Marshall	9,921,245	7,796,731	6,727,476	–32
Woodford	2,350,511	2,420,600	2,353,795	<1
Hancock	3,750,587	2,592,979	2,097,514	–44
Scott	37,016	780,893	2,008,871	+5,327
Logan	1,829,826	1,815,244	1,540,277	–16
Boyd	1,745,434	1,540,908	1,333,720	–24
Hopkins	1,043,246	947,592	1,021,300	–2
Madison	821,367	1,040,541	881,585	+7
Simpson	1,062,632	806,600	848,752	–20
Totals	**34,486,412**	**32,790,787**	**30,585,509**	**–11**

Source: Kentucky Department for Environmental Protection Toxic Chemical Release Inventory Data, 1988, 1989, 1990

60% of Air Toxic Releases are Highly Toxic Chemicals

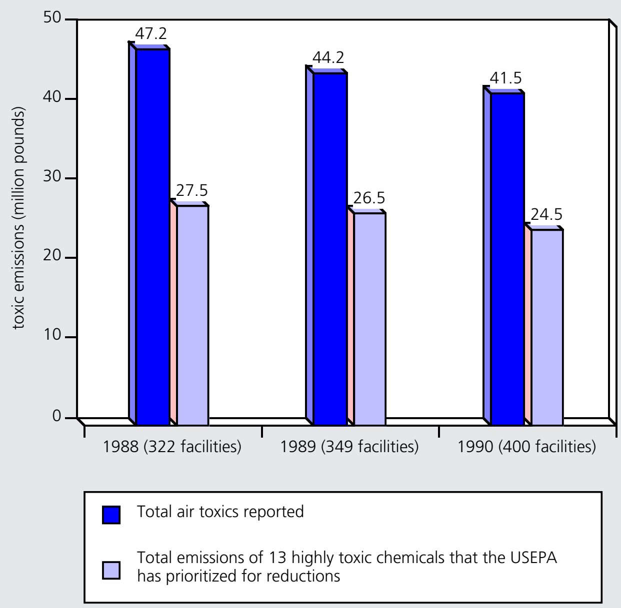
Nearly 60% of the 41.5 million pounds of air toxics released in Kentucky during 1990 were highly toxic chemicals **(Figs. 24 and 25)**. The U.S. EPA has prioritized 17 chemicals for reductions because of the threats they pose to human and ecological welfare. During 1990, 23 facilities reported air emissions of 13 of these chemicals in excess of 100,000 pounds and three facilities released more than 1 million pounds **(Fig. 26)**. Many of these chemicals are known or suspected human carcinogens. For example, between 1988 through 1990, industrial emissions of benzene, a known human carcinogen, exceeded one million pounds. The majority of benzene was released in Boyd and Marshall counties.

Some facilities in Kentucky are making significant efforts to reduce toxic pollutants. A few examples follow:

- B.F. Goodrich, Marshall County, reduced air emissions by 25% between 1987 and 1989. The company expects further reductions for the reporting year 1990.
- Hi–Tek Polymers, Jefferson County, is currently developing on–site recovery/recycling processes expected to reduce toxic air emissions by up to 50%.
- GAF Chemicals, Marshall County, installed air pollution control devices and improved controls on fugitive emissions to achieve a 78% reduction in air emissions between 1987 and 1989.
- Ford Motor Company, Jefferson County, indicates that process changes are being evaluated to reduce air toxics. The company uses emission controls for paint solvents.
- G.E. Appliances, Jefferson County, expected air emission reductions of more than 200,000 pounds by 1991. Company officials have not yet determined if that goal was achieved. Major product redesigns and process changes are expected to reduce total air emissions 70% by the year 2000.
- American Synthetic Rubber Corporation, Jefferson County, indicates that toluene emissions are targeted for reductions by purifying and reusing solvents, upgrading leak detection systems, and through the use of a flare system which burns the solvent as it is released.

The U.S. EPA has prioritized 13 highly toxic chemicals released to the air for reductions because of the threats they pose to health and the environment.

Figure 24
Statewide Industrial Toxic Air Emissions



Source: Kentucky Department for Environmental Protection Toxic Chemical Release Inventory Data, 1988, 1989, 1990

Nearly 60% of all reported toxic air emissions released in Kentucky during 1990 were highly toxic. Statewide, these highly toxic emissions declined 11% between 1988 and 1990.

Figure 25
Industrial Air Releases in Kentucky Considered Highly Toxic* (pounds)

Chemical	**1988**	**1989**	**1990**	**% Change 1988–1990**
Benzene	548,800	544,078	661,314	+17
Carbon Tetrachloride	30,931	32,412	13,208	–57
Chloroform	513,557	325,335	234,080	–54
Cyanide & Compounds	84,293	39,934	45,136	–46
Dichloromethane	1,536,888	1,491,154	1,404,288	–9
Lead & Compounds	1,297,743	1,294,582	584,190	–55
Methyl Ethyl Ketone	1,271,130	1,599,970	1,767,400	+28
Methyl Isobutyl Ketone	990,272	1,420,688	937,592	–5
Methylchloroform *(1,1,1-Trichloroethane)*	2,684,011	2,289,791	2,327,608	–13
Perchloroethylene	586,847	744,507	585,180	<1
Toluene	11,565,364	10,161,578	9,464,102	–18
Trichloroethylene	767,587	649,953	607,212	–21
Xylenes	5,642,573	5,877,684	5,840,523	+3
Totals	**27,519,996**	**26,471,666**	**24,471,833**	**–11%**

**Some of these compounds are known or suspected carcinogens.*
Source: Kentucky Department for Environmental Protection Toxic Chemical Release Inventory Data, 1988, 1989, 1990, U.S. EPA

Figure 26
Kentucky Sources Releasing 100,000 Pounds or More of Chemicals Considered Highly Toxic*

County	Facility	Chemical Released (% of total state releases)
Boyd	Armco Steel	Benzene (37)
Boyd	Ashland Petroleum–Cat.	Benzene (30), Toluene (1)
Hancock	Willamette	Chloroform (78)
Logan	E. R. Carpenter	Dichloromethane (51), Methyl Chloroform (22)
Hardin	Gates Rubber	Dichloromethane (13)
Jefferson	G E Appliances	Dichloromethane (13), Methyl Chloroform (4)
Christian	Autostyle Plastics	Methyl Ethyl Ketone (18)
Hardin	Ambrake Corp.	Methyl Ethyl Ketone (8)
Jessamine	Norris Trim	Methyl Ethyl Ketone (7)
Scott	Toyota Motor	Methyl Isobutyl Ketone (39), Toluene (1), Xylene(8)
Jefferson	American Synthetic Rubber	Toluene (61)
Jefferson	Standard Gravure	Toluene (12)
Simpson	Brown Printing	Toluene (7)
Grant	Sun Manufacturing	Toluene (2)
Taylor	Batesville Casket	Toluene (1)
Mercer	Signet Systems	Trichloroethylene (35)
Woodford	GTE Products	Xylene (45)
Warren	General Motors	Xylene (4)
Jefferson	Ford Motor	Xylene (5)
Logan	Emerson Electric	Xylene (2)
Hopkins	GE Aircraft	Methyl Chloroform (7)
Mason	Browning Manufacturing	Methyl Chloroform (4)
Nelson	Jideco of Bardstown	Methyl Chloroform (4)

**Some of these compounds are known or suspected carcinogens.*
Source: Kentucky Department for Environmental Protection
Toxic Chemical Release Inventory Data, 1990

415 Sources Report Air Toxic Emissions in 1991

In 1986, DAQ adopted state standards that regulate 92 air toxics emitted by existing facilities and 736 air toxics for new or expanding facilities. The regulations require existing sources emitting any of the 92 air toxics to install reasonable control technologies. New sources are subject to more stringent requirements. Sources emitting any of the 736 listed air toxics must install best available control technologies.

In 1987, DAQ received nearly 500 applications which required review for air toxics. In 1988, 75 facilities had air toxic provisions in their permits. That number has increased, but DAQ was unable to provide the current total number of facilities with permitted air toxic provisions.

State regulations also require sources emitting air toxics to demonstrate compliance and report production information so that the amount of toxic emissions can be determined by DAQ. The number of facilities reporting air toxics has increased yearly as more facilities are permitted. In 1988, there were 184 facilities reporting; during 1989, 270 reported; and in 1990, 371 sources reported air toxics to DAQ. During the ten–month period from January through October 1991, 415 facilities reported production activities which resulted in toxic air emissions. Because actual state permitted toxic air emissions cannot be compiled by DAQ under its current data management system, a comparison of these releases and the 44.2 million pounds of air toxics reported by companies under the federal Toxic Chemical Release Inventory program cannot be made.

The new air toxics requirements under the Clean Air Act Amendments will focus attention on a relatively small list of approximately 190 chemicals. For the first time, a national comprehensive strategy will be developed to address these toxic emissions and their impacts on human health. The strategy will be implemented in two phases. The first will determine the extent to which emissions reductions are achievable using technology–based control strategies for various source categories. In the second phase, the risks to humans from the toxic emissions remaining after controls are imposed will be evaluated. Additional reductions will be mandated if the remaining risks are determined to be too great.

The national air toxics strategy will take several years to implement. DAQ indicates that it will incorporate these requirements into the state's existing air toxics regulations as they take effect.

Enforcement

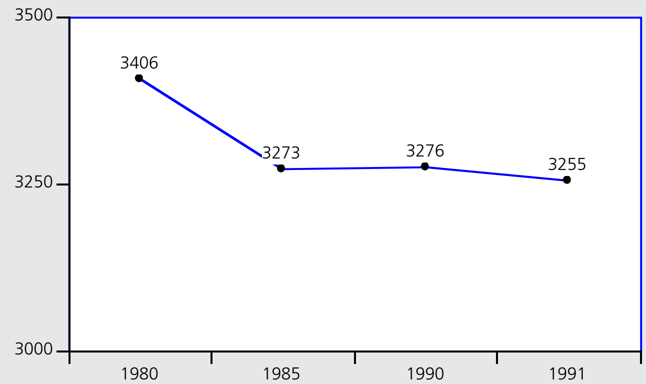
Six Percent of 3,255 Permitted Facilities Out of Compliance; 28% in Jefferson County in Violation of Air Quality Rules

DAQ currently permits 3,255 facilities, including those overseen by the Jefferson County Air Pollution Control District. In 1991, 171 facilities, or 6% of all permitted facilities (excluding Jefferson County), failed to comply with air quality regulations **(Fig. 27)**. DAQ was unable to provide data on the type of violations. Twenty–eight percent of the 480 major facilities permitted in Jefferson County were out of compliance during 1991. The Jefferson County Air Pollution Control District was also unable to provide historical data regarding compliance and violation categories. The reason for the significant difference in the percent of permitted facilities that are out of compliance statewide and in Jefferson County could not be determined by DAQ.

According to DAQ, about 75% of its enforcement activities have been focused on facilities constructed without proper permits. DAQ indicates that these violations are decreasing and enforcement efforts are now emphasizing illegal emissions of air pollutants. The Division has increased the number of violations issued in recent years. In 1991, DAQ collected $232,000 in penalties for violations of air quality standards. This was far less than in 1990 when $976,000 were collected, due primarily to a major penalty assessment against Ashland Oil for past violations **(Fig. 28)**.

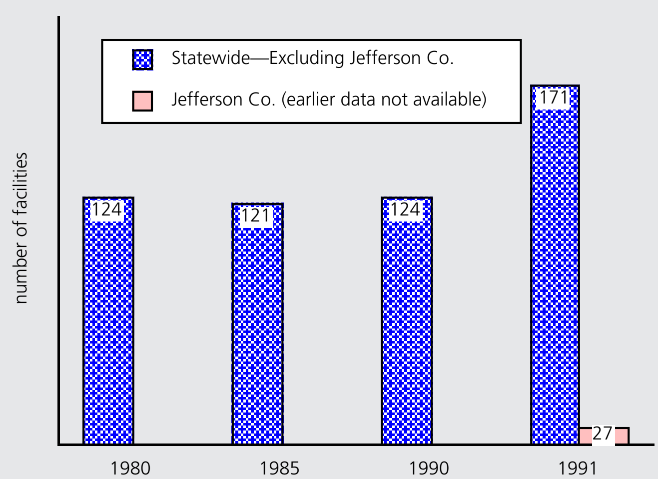
The number of complaints received by DAQ has more than doubled during the last ten years, from 792 in 1980, to 1,741 in 1990. The majority of these complaints were regarding odor, dust, open burning, and asbestos **(Fig. 29)**.

Figure 27
Total Number of Kentucky Facilities with State Air Quality Permits



Note: Includes Jefferson County.

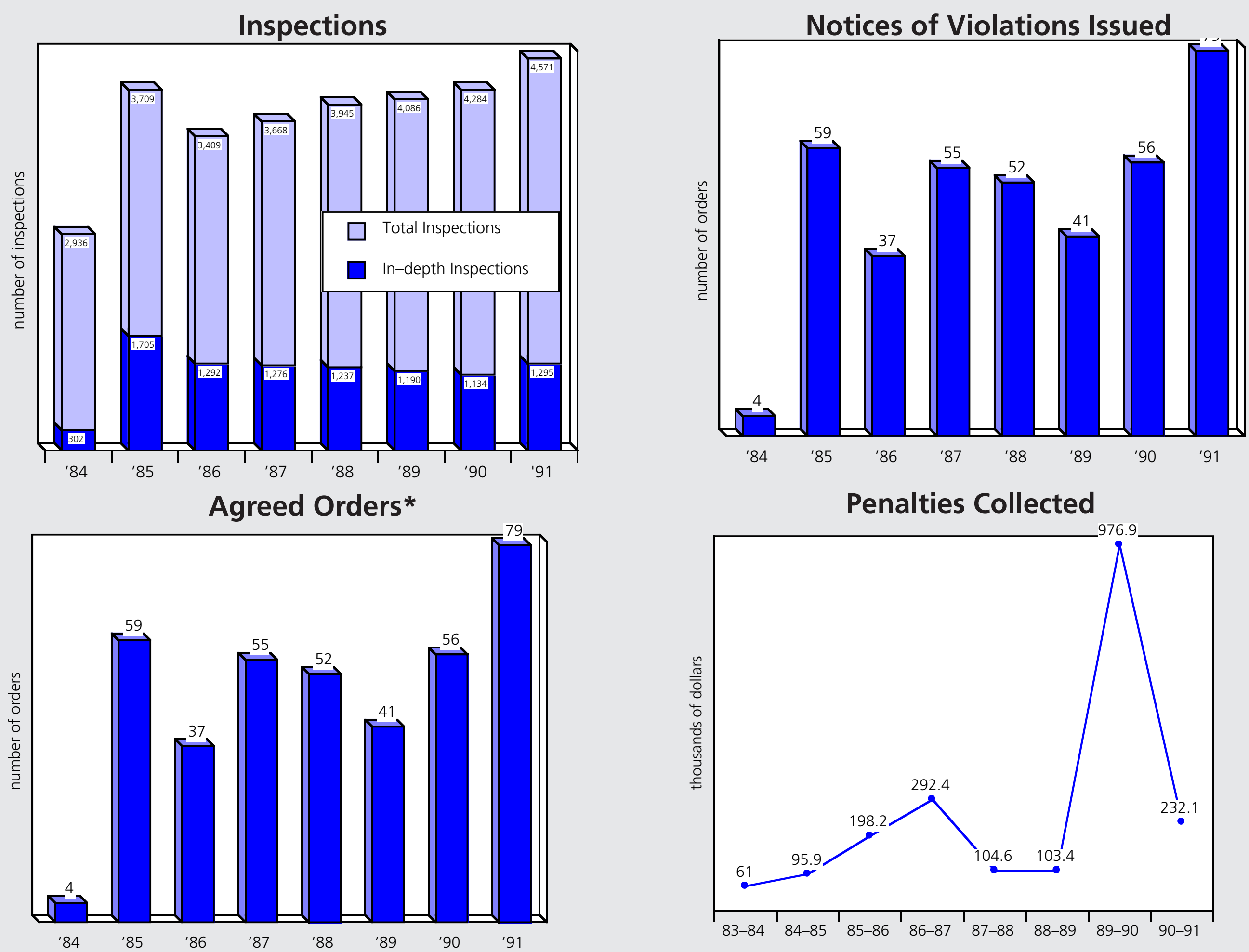
Number of Kentucky Facilities Out of Compliance with Air Quality Standards



Note: Data do not include service stations. Jefferson County percents were derived based on 480 existing facilities.
Source: Kentucky Division for Air Quality; Jefferson County Air Pollution Control District, 1992.

During 1991, about 6% of the 3,255 facilities permitted by the Kentucky Division for Air Quality failed to comply with existing laws and regulations. Twenty-eight percent of the 480 major facilities permitted by the Jefferson County Air Pollution Control District were out of compliance.

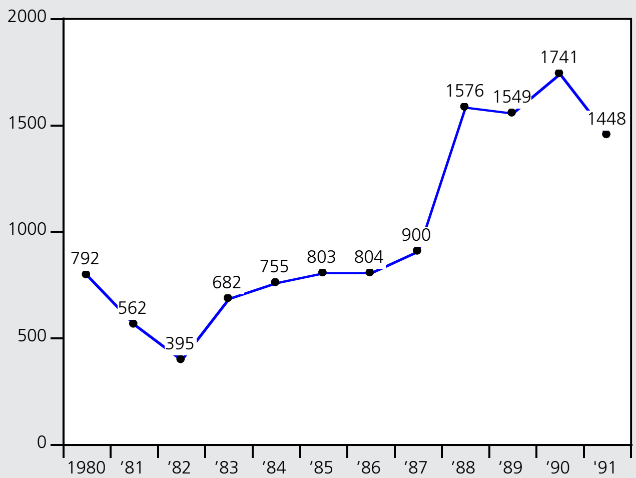
Figure 28
State Air Quality Enforcement Activities



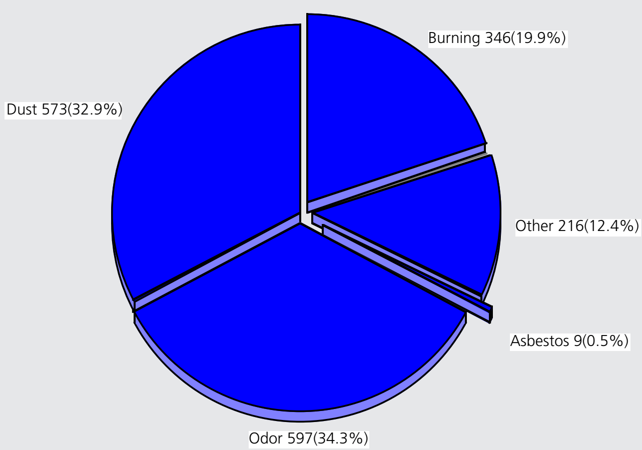
Note: Violations data represent USEPA fiscal years (Oct.–Sept.).
**Agreed orders are contracts between violators and the Cabinet for Natural Resources and Environmental Protection which outline environmental violations, appropriate remedial measures, and civil penalties.*
Source: Kentucky Division for Air Quality, 1991

The Division for Air Quality has primarily focused its enforcement efforts on facilities constructed without permits. Since these violations are declining, the Division recently shifted its emphasis to controlling illegal emissions of air pollutants.

Figure 29
Number of Complaints Regarding Air Quality Problems in Kentucky



Air Quality Complaints by General Category*



**Based on 1,741 complaints received in 1990*

Source: Kentucky Division for Air Quality, 1991

Citizen complaints regarding air quality more than doubled during the last decade in Kentucky. Most complaints are received from the Ashland and Calvert City areas.

Air Quality Complaints in Ashland Area Result in Study; Air Toxics Monitoring Underway to Confirm High Formaldehyde Levels

The citizens of Catlettsburg, Kentucky and Kenova and Ceredo, West Virginia have repeatedly complained about air quality in the Ashland, Kentucky area. Between 1983 and 1988, 798 complaints were received by DAQ and West Virginia air pollution control officials from this region. In 1988, at the urging of local citizens, the West Virginia Congressional delegation requested assistance from the U.S. EPA in assessing air quality problems in the Catlettsburg/ Kenova area. State officials from Kentucky, West Virginia, and Ohio, took part in the study commissioned by the U.S. EPA.

The study, completed in November 1990, reviewed emissions from 15 major sources of air pollution in the region. The emissions included sulfur dioxide, particulates, nitrogen oxide, and volatile organic compounds. The study also included monitoring for toxic air pollutants and revealed that concentrations of formaldehyde in the Ashland area air were ten times higher than the national average. However, that portion of the study is being repeated by the U.S. EPA to verify the formaldehyde levels. None of the other pollutants monitored exceeded acceptable limits at the time the study was conducted.

The U.S. EPA is considering an extensive follow-up study for the area. The second study may include testing for contamination of ground and surface water and a health survey, in addition to air quality monitoring. The study, if approved, would also include the development of pollution reduction strategies.

Acidic Deposition (Acid Rain)

Some air pollution problems result from the transport of pollutants hundreds of miles downwind of an emission source. One of these problems is acidic deposition, commonly known as acid rain. Many researchers attribute the formation of acid rain to emissions of sulfur dioxide (SO_2) and oxides of nitrogen (NO^x) which are released primarily when fossil fuels are burned for energy.

Recent amendments to the Clean Air Act require significant reductions in the emission of pollutants believed to be responsible for the formation of acid rain. Many Kentuckians are familiar with this issue because of the impact emission reduction strategies may have on the production of high sulfur coal from Western Kentucky.

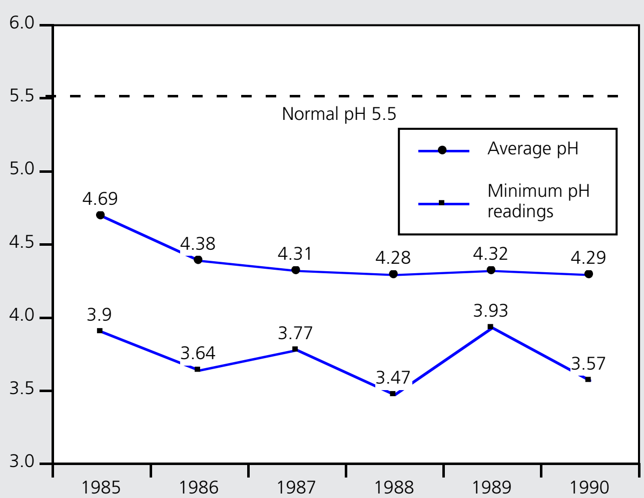
Industrial Emissions in Ohio River Valley Contribute to Acid Rain; Kentucky Rainfall Becoming More Acidic

According to a National Acid Precipitation Assessment Program study published in 1991, 4.2% of all lakes and 2.7% of all streams monitored in the United States are acidified. This report indicates that one–third of the acidification occurred in the Northeastern U.S., one–third in Florida, and one–third in the Midwest. Canadian studies have concluded that an estimated 45,000 lakes are so acidic that they no longer support normal aquatic populations.

Much of the damage is believed to be caused by SO_2 and NOx emissions from industries located in the Ohio River Valley. It is believed that these pollutants are transported by prevailing winds to the Northeastern U.S. and Canada where they help to form acid rain. Canada has pressured the U.S. government to reduce SO_2 emissions.

Kentucky's naturally alkaline rocks and soils provide neutralization to assist in protecting the state's waters from noticeable acidification damage. However, rainfall in the state has become increasingly acidic, and presently has an average pH of 4.3 which is more acidic than the 5.5 pH of normal rainfall **(Fig. 30)**. In addition to lake and stream acidification, acid rain is blamed for premature deterioration of outside building materials, adverse health effects, and damage to forests and other vegetation.

Figure 30
Average pH of Kentucky Rainfall



Note: Values shown are based on data collected at two monitoring stations and reflect the geometric mean rather than volume weighted averages.
Source: Kentucky Division for Air Quality monitoring data, 1991

Kentucky's rainfall is becoming increasingly acidic and is currently more acidic than normal rain. The state's naturally alkaline rocks and soils provide neutralization to assist in protecting the state's water resources from acid rain damage.

17 of State's 58 Coal–Fired Power Plants Install Scrubbers to Control Emissions Linked to Acid Rain; Additional Reductions at Other Plants Required

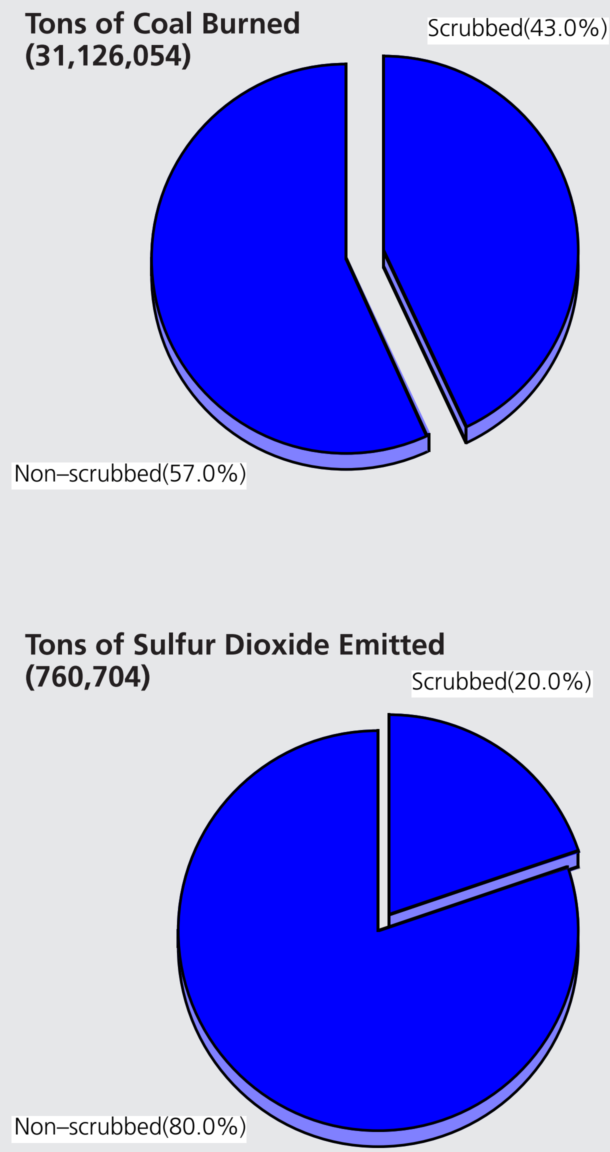
Increasing evidence of the threats to the environment from acid rain have sparked more stringent control strategies for SO_2 emissions. The 1990 Clean Air Act Amendments require major reductions in SO_2 emissions within the next five years, and additional reductions by the year 2000. Coal–fired power plants contribute 85–90% of all SO_2 emissions in Kentucky, therefore, most reductions are expected to be made at these facilities.

In an attempt to maintain air quality and reduce acid rain precursors, the U.S. Congress has set limits on the amount of SO_2 emitted nationwide. An emissions cap was set at 8.9 million tons annually. This was necessary because the demand for electricity has continued to increase due to an expanding population and economic growth. Without a cap, this growth would result in increased SO_2 emissions despite the stricter controls placed on individual facilities. The cap will require facilities to become more efficient if growth continues and encourage additional emission controls or closure of older inefficient facilities. It will also encourage increased use of low sulfur coal and clean coal technologies. The emissions cap, however, may not actually result in SO_2 emission reductions from coal–fired utilities in Kentucky because of the availability of a provision to "trade" emission allowances. These allowances can be traded or purchased from any U.S. facility that achieves reductions above the requirements.

One method used by coal–fired facilities to reduce SO_2 emissions is to install "scrubbers." Scrubbers are air pollution control devices that trap some pollutants before they are emitted. In 1989, 57% of the coal burned in Kentucky was non–scrubbed and accounted for 80% of the SO_2 emitted. Scrubbed coal accounted for 43% of the coal burned by power plants but only 20% of the SO_2 emissions **(Fig. 31)**. As shown in Figure 19, of the 58 coal–fired power plant units operating in

Figure 31

Sulfur Dioxide Emissions from Kentucky Coal-Fired Power Plants (1989)



Note: 1989 data most recent available

Source: Kentucky Division for Air Quality, 1991

The 17 coal-fired power plants in Kentucky that have installed scrubbers emit far less sulfur dioxide. Additional emissions reductions are mandated by the new Clean Air Act which will require other state power plants to scrub coal or otherwise control sulfur dioxide emissions.

Kentucky, 17 have installed scrubbers. The estimated cost to install a scrubber ranges from $50 million to $300 million, depending on its size and efficiency. Ten more power plants in the state will be required to reduce their SO_2 emissions or take advantage of trading emission allowances by 1995. The remainder of the state's power plant units will be required to reduce emissions before the year 2000.

Global Warming and Ozone Depletion

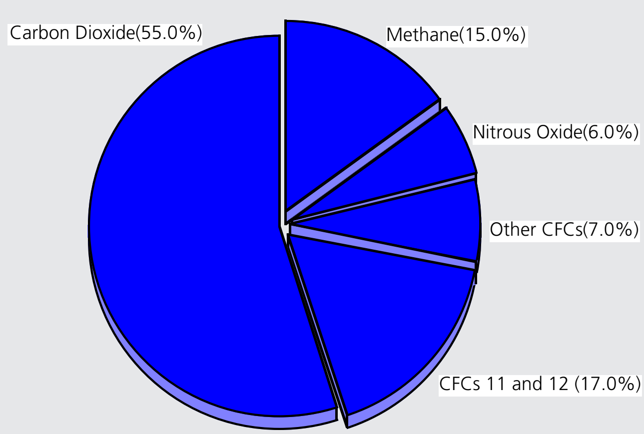
Global warming is one of the most complex air quality problems facing the world today. The appearance of a slow, yet steady rise in the earth's average temperature is now attributed to increasing levels of greenhouse gases (carbon dioxide, nitrogen oxides, and methane) in the atmosphere, and the depletion of the earth's protective stratospheric ozone layer **(Fig. 32)**.

Naturally occurring gases in the atmosphere absorb the heat reflected from the earth. This process, called the "greenhouse effect," warms the earth making it habitable. However, many human activities, especially the burning of fossil fuels such as petroleum and coal, and deforestation, are rapidly increasing the amount of greenhouse gases in the atmosphere. This increase, coupled with the depletion of the protective stratospheric ozone layer, is believed to be enhancing the greenhouse effect, causing average global temperatures to rise. The rising temperatures are predicted to have widespread impacts on climate, ocean levels, agricultural production, and water supplies during the next several decades and beyond.

Greenhouse Gases Increasing, Causing Rising Temperatures; National Strategies to Control Emissions Predicted

According to the U.S. Department of Energy, corroborating studies indicate that greenhouse gases in the atmosphere have increased along with the rising temperatures. Atmospheric concentrations of carbon dioxide, the major greenhouse gas, have increased steadily since the 1980s. There has been a dramatic 25% increase in atmospheric carbon dioxide during the last 100 years, with the greatest rate of increase occurring since 1960, according to scientific reports. This pollutant is expected to continue to increase in the atmosphere by approximately 0.5% a year.

Figure 32
Relative Contribution of Greenhouse Gases to Global Warming



Note: The impact of tropospheric ozone cannot presently be quantified.
Source: US EPA and IPCC Scientific Assessment, 1991

Greenhouse gases, especially carbon dioxide, are a result of many human activities. These gases are increasing in the atmosphere and are believed to be causing a steady rise in world temperatures, known as global warming.

Carbon dioxide emissions come from many sources, but most are generated from electrical and industrial production and transportation activities **(Fig. 33)**. Data are not available from DAQ to determine carbon dioxide emission trends for Kentucky. The U.S. EPA is expected to impose additional carbon dioxide reduction strategies in the near future.

Emission trends for nitrogen oxide, another greenhouse gas, are presented earlier in this chapter. Methane gas emissions also contribute to upper atmospheric problems. Typical sources include solid waste landfills, natural gas pipelines and pumping stations, oil refineries, coal mining operations, and some chemical manufacturers. These sources are not required to report emissions to the state, therefore, no estimates on methane gas emissions can be provided.

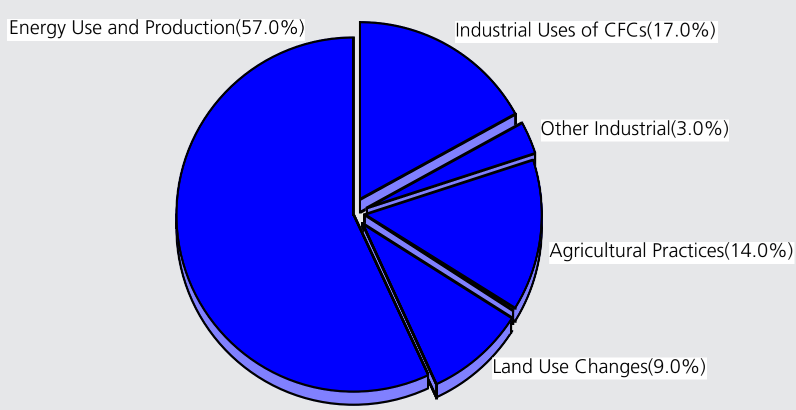
It appears likely that greenhouse gases will continue to increase in the atmosphere if fossil fuel consumption continues to increase. Emission reductions required by the 1990 Clean Air Act Amendments to control acid rain and groundlevel ozone are expected to help curb greenhouse gas emissions. However, many contend that much more needs to be done to reduce greenhouse gas emissions.

The use of a “carbon tax” is currently being debated nationally as a measure to reduce carbon–based emissions by encouraging the conservation of fossil fuels and the development of less polluting alternative fuels. In Kentucky, the Governor’s Office for Coal and Energy Policy estimates that a carbon tax could result in an average 10–15% increase in the cost of electricity in the state. Kentucky will continue to be involved in these important issues because of the state’s coal industry and Kentucky's potential for producing alternative fuels to meet future energy demands.

During June 1992, leaders from all countries around the world will come together for the United Nations "Conference on the Environment and Development" in Rio de Janeiro, Brazil. At the conference, known as the "Earth Summit," governments will address the problems of global climate change and work to negotiate solutions to slow global warming and ozone depletion, in addition to many other topics. The conference represents the first large scale effort to address global environmental problems in a holistic manner and is being held under the auspices of the United Nations General Assembly.

Figure 33

Sources Contributing to Global Warming



Note: The impact of tropospheric ozone cannot presently be quantified.
Source: USEPA and IPCC Scientific Assessment, 1991

Fossil fuel production and use contribute most of the pollutants associated with global warming. The world’s leading atmospheric scientists are calling for immediate efforts to reduce greenhouse gases.

Ozone Depletion Worse Than Believed; Phase–Out of CFCs Results in 55% Decline in Kentucky Emissions

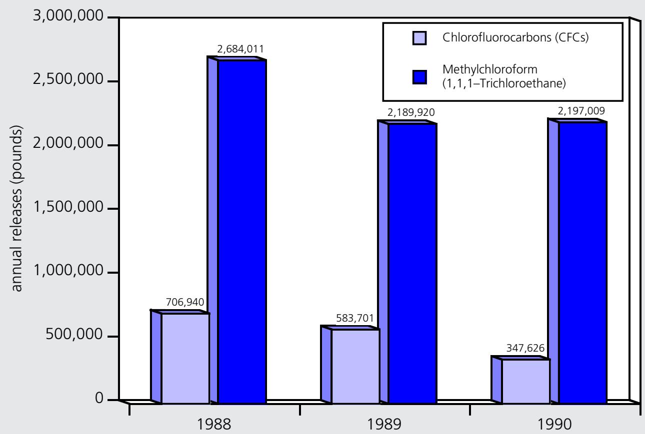
The loss of the protective stratospheric ozone layer is believed to be contributing to global warming by allowing more of the sun's rays to pass through the earth's atmosphere and warm the planet. The ozone layer, which surrounds the earth and shields out ultraviolet radiation, is being destroyed twice as fast as was recently thought. An 11–year study by the National Aeronautics and Space Administration indicates that 4.5% of the ozone layer over the United States has been lost since measurements began in 1978. Stratospheric ozone depletion can contribute to other problems as well including damage to plants and humans. By allowing more harmful ultraviolet radiation to penetrate through the earth's atmosphere, the loss of the stratospheric ozone layer is causing a dramatic increase in the number of skin cancers and related deaths.

Ozone depletion is caused primarily by the widespread use and release of chemicals such as chlorofluorocarbons (CFCs) and halons into the air **(Fig. 34)**. In response to this serious problem, the manufacture of CFCs (chemicals used primarily as propellants and refrigerants in appliances such as refrigerators, air conditioners, freezers, and industrial refrigeration units) will be phased out. The U.S. government has agreed to completely phase out CFC production by the year 2000, although recent reports indicate that an earlier ban may be mandated because of new evidence showing the problem to be worse than originally believed. Current emissions of CFCs will continue to destroy the ozone layer long after they are no longer in use since it takes many years for these chemicals to migrate into the stratosphere. Methylchloroform, carbon tetrachloride, and halons (used as a fire extinguisher agent) are also targeted for reduction under the 1990 Clean Air Act Amendments since they also destroy ozone. Expanded reporting requirements have been implemented for these compounds and their use will also be curtailed.

The total amount of all CFCs and other ozone depleting chemicals released in Kentucky cannot be determined because there are many different sources, most of which are not required to report emissions. Reporting by some industrial emitters of CFCs has been required during the last few years **(Fig. 35)**. State CFC emissions from these sources declined 51% between 1988 and 1990 as a result of the national phase–out schedule. Emissions of methylchloroform declined between 1988 and 1990 by 18%. There is concern that some of the reductions may be offset by the use of chemical substitutes, which are not required to be reported, but may also destroy ozone.

The 1990 Clean Air Act Amendments mandate that CFCs, which are now vented to the air when air conditioners are serviced, be recycled. Effective January 1, 1992, the act requires repair technicians performing service on vehicle units to be trained in proper handling procedures and to use only certified equipment to recycle the CFCs. By July 1, 1992, it will be unlawful to vent CFCs during servicing or disposal of vehicle, home, and industrial refrigeration units.

Figure 34
Air Emissions of Ozone Depleting Chemicals in Kentucky



Note: Includes reported industrial emissions of chlorofluorocarbons (CFCs) and methylchloroform.
Source: Kentucky Department for Environmental Protection: Toxic Chemical Release Inventory Data

The depletion of the Earth's protective ozone layer, which is now known to be far worse than previously believed, is linked directly to the use and release of various chemicals, especially chlorofluorocarbons (CFCs) and halons into the air. Reported industrial emissions of CFCs are declining in Kentucky due to an international phase–out effort.

Chlorofluorocarbon (CFC) emissions from industrial reporting sources declined 51% between 1988 and 1990. Additional requirements to recapture CFCs when air conditioners are serviced will take effect in 1992.

Figure 35
Chlorofluorocarbon (CFC) Emissions From Selected Industrial Sources (pounds)

Company	County	1987	1988	1989	1990
General Electric	Jefferson	211,000	176,850	227,000	100,877
General Electric	Allen	156,400	NR	NR	NR
Premium Allied Tool Inc.	Daviess	NR	76,622	89,259	61,062
Hitachi Auto Products	Mercer	30,307	56,589	42,575	31,084
Lexmark/IBM	Fayette	66,270	100,387	40,306	22,164
Eaton Corp.	Warren	24,000	90,000	NR	NR
Potter and Brumfield	Simpson	1,500*	61,015	56,659	30,220
Vermont American Corp.	Hardin	NR	750	750	40,300
Gates Rubber Polyflex	Hardin	NR	13,500	24,000	20,000
Holley Replacement Parts	Warren	NR	12,406	20,882	10,094
Ken-Tron	Daviess	11,480	14,490	11,040	9,220
GTE Valenite	Hopkins	13,986	18,066	11,028	NR
Micro Devices Division					
Therm-o-Disc	Laurel	11,730	22,289	14,527	NR
Total	**10**	**526,673**	**642,964**	**538,026**	**325,001**

NR—none reported
**1987 emissions data were reported for the facility located in Crittenden County, 1988–90 were from the Simpson County facility.*
Source: Kentucky Department for Environmental Protection Toxic Chemical Release Inventory Data, 1991

Indoor Air Quality

National attention is being focused on the problems associated with indoor air pollutants such as radon gas, environmental tobacco smoke, asbestos, and chemicals commonly used in household cleaners, solvents, and building materials. The U.S. EPA is increasing its efforts to address exposure to these pollutants because the average person spends 80 to 90% of the day indoors.

The U.S. EPA plans to develop better strategies for reducing the risks associated with exposure to indoor air contaminants. With the exception of asbestos, DAQ currently has no regulatory authority to conduct monitoring and control programs for these indoor pollutants. The Division indicates that indoor air issues are a significant concern, but implementing regulations to oversee the environment inside private residences is not considered feasible. Workplace standards do exist, or are under consideration, for some indoor pollutants.

The U.S. EPA and DAQ maintain that there is a significant need for educational programs regarding indoor air quality issues, and the agencies distribute information as requested. The Kentucky Cabinet for Human Resources oversees the state's radon gas program and provides educational materials and other guidelines regarding radon issues.

High Radon Gas Levels Recorded in Central Kentucky; 17% of Homes Tested in State Exceed Health Advisory Limits

Radon is a colorless, odorless gas that occurs naturally in the environment in rocks and soils. Radon becomes an indoor air pollutant when it enters buildings through cracks in foundations and basements. It is also found in building materials and well water, and is most acute when there is poor ventilation.

In the U.S., 82% of the population's radiation exposure comes from natural sources. Fifty–five percent of this is contributed by radon and its decay products. The importance of environmental radon as a significant source of human radiation exposure has only recently been recognized. Radon and related decay products which exceed concentrations above certain levels, are suspected to cause or aggravate serious health problems. According to the U.S. EPA, radon can cause lung cancer and may be responsible for 4,000 to 10,000 lung cancer deaths each year. The U.S. EPA based the estimate of lung cancer deaths on research conducted with uranium miners exposed to elevated levels of radon.

In 1987, the U.S. EPA conducted a radon survey in Kentucky. Radon levels were measured in 876 randomly chosen homes located throughout all regions of the state. The results showed that homes in several regions had concentrations above levels considered safe **(Figs. 36 and 37)**. Statewide, 17% of homes tested had radon levels which exceeded the health advisory limits set by the U.S. EPA.

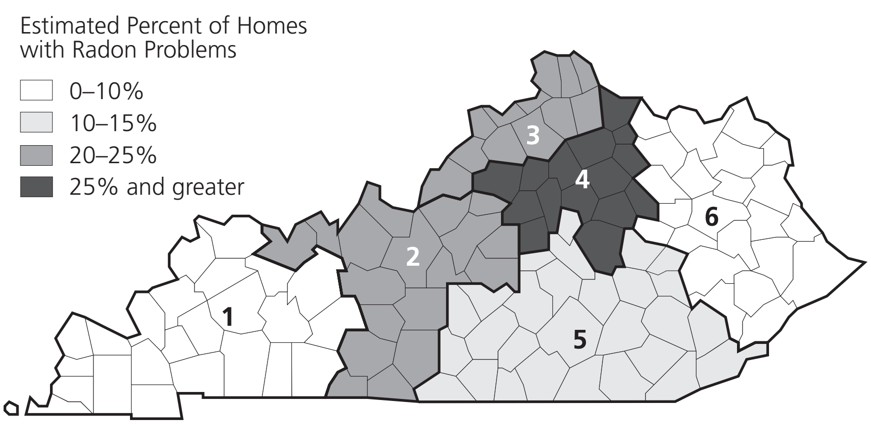
Some areas of the state had a significantly higher percentage of homes with radon levels high enough to require remedial action. In the central region, 34.6% of homes tested had high radon levels. This is due to the area's geological characteristics which are associated with naturally occurring radium and uranium. The level of radon and related decay products in homes and buildings is highly variable even within the same region as a result of many factors, including building construction styles and ventilation, as well as the concentration of radon in soils.

Homeowners with radon and decay product levels above safe limits were advised to conduct additional testing and take steps to reduce radon exposure. The Kentucky Cabinet for Human Resources in its "Healthy Kentuckians 2000" report, recognized the problem of radon gas and has assumed the responsibility of educating the public on radon issues. The Cabinet will also begin licensing contractors who test for radonon in 1993. The Kentucky Department of Education is currently surveying schools for radon, but the results are not yet final.

The U.S. EPA is scheduled to publish a "high potential radon map" early in 1993 that will identify areas with known problems. This information is expected to encourage builders to follow building standards which prevent radon exposure. The Homebuilders Association of Kentucky indicates that many builders in Jefferson County are currently using construction practices to prevent radon problems. The organization is working to educate builders around the state in these practices. Also, an increasing number of lending institutions in Kentucky are requiring radon tests and mitigation projects when high radon levels are detected.

Seventeen percent of homes tested for radon statewide had levels exceeding the health advisory limits (4pCi/L). The state recommends that all Kentucky homes and buildings be tested for radon problems.

Figure 36
Radon Levels by Region



Measurements of Households Surveyed

Region	Households Tested	% Households 0–4.0 pCi/L	% Households 4.1–20.0 pCi/L	% Households above 20 pCi/L
1	168	2.2	2.2	0.0
2	153	21.7	17.7	4.0
3	207	20.7	19.4	1.3
4	143	34.6	32.6	1.9
5	102	14.9	12.8	2.1
6	106	6.2	6.2	0.0
Statewide	879	17.1	15.6	1.5

Source: Kentucky Cabinet for Human Resources, 1991

Figure 37
Kentucky Counties with Highest Recorded Radon Levels in Homes

County	Radon level recorded (pCi/L)
Bullitt	66
Warren	32
Bourbon	31
Scott	29
Warren	28
Warren	27
Hart	25
Jefferson	25
Bullitt	24
Cumberland	23

Note: These single measurements may not be representative of all homes in these counties. Adverse health effects may occur from radon exposure above 4 pCi/L
Source: Kentucky Cabinet for Human Resources, 1991

Some areas of the state had a significantly higher percentage of homes with high radon levels. This is due to the state's naturally occurring radium and uranium. Homeowners with high radon levels were advised to take steps to reduce exposure.

Federal Rules Expected to Control Exposure to Tobacco Smoke in the Workplace

The issue of involuntary exposure to environmental tobacco smoke (ETS), or "passive smoking," has recently risen to a national debate. Scientific studies have shown that significant risks are associated with exposure to this pollutant. The U.S. Surgeon General, the U.S. EPA, the National Cancer Institute, and other health and public protection agencies have concluded that passive smoking causes lung cancer, heart disease, and other health problems in non–smokers exposed to ETS in the workplace, public buildings, and homes.

Passive smoking is now ranked as the third leading cause of preventable death in the U.S. and may present a greater risk than many pollutants currently regulated. ETS is particularly a problem in Kentucky because the state has a high percentage of smokers, although the smoking rate has declined from 32% of the state's population in 1988, to 29% in 1990.

State efforts to regulate ETS in the workplace have been limited. The Cabinet for Human Resources has established goals to reduce smoking rates in Kentucky through increased educational efforts. Some private businesses including major insurance companies, newspapers, churches, and others have banned or heavily restricted ETS from the workplace. All hospitals accredited by the Joint Commission on Accreditation of Health Care Organizations (approximately 100 in Kentucky) began banning smoking in January 1992. All federal buildings are smoke free or restrict smoking to separately ventilated areas.

The National Occupational Health and Safety Administration (OSHA) is planning to identify ETS as an occupational carcinogen. OSHA is expected to issue regulations which will prohibit exposure to this pollutant in the workplace. Employers have been advised by OSHA to begin to eliminate workplace exposure to ETS due to its risks to exposed persons.

Asbestos Problems Identified in Kentucky Schools; Many State Buildings Await Asbestos Inspections

Asbestos is a material that has been associated with indoor air pollution. Asbestos has been used in many products, especially in building construction materials and is commonly found in ceilings, walls, pipe coverings, floor tiles, and brake pads. It has been widely used because it is non–combustible and resistant to corrosion and chemical breakdown.

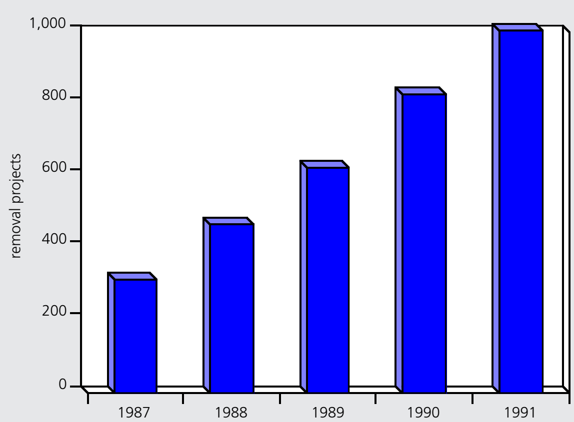
Asbestos fibers are known to cause cancer and other human health problems when inhaled into the lungs. People exposed to high concentrations of airborne asbestos are at greater risk for developing lung cancer, asbestosis, and other associated disease. Exposure is often the greatest when buildings containing asbestos are remodeled or demolished. Natural deterioration in buildings can also release inhalable fibers that accumulate in the lungs and cause respiratory-related disease and cancer.

DAQ regulates asbestos emissions and removal projects in institutional, commercial, and industrial structures **(Fig. 38)**. The Division currently certifies about 100 asbestos removal contractors and regularly inspects projects. The state also accredits 33 inspectors to survey schools for asbestos.

Children are particularly at risk from asbestos since the latency period between exposure and adverse health effects is ten to 40 years. Some of the highest asbestos concentrations have been found in schools. All schools were required to be inspected for the presence of asbestos and prepare management plans for its safe removal. Since October 1988, DAQ has received and reviewed 3,685 school plans and approximately 223 removal projects have been conducted, 113 of which occurred during 1991. About one–fifth of the 551 inspections conducted by DAQ for asbestos were performed at schools. Many smaller removal projects have also been initiated.

In the mid–1980s, the Kentucky Attorney General's (AG) office set up a task force to investigate the increasing number of citizen complaints regarding asbestos. The AG's office determined that of the 5,500 state–owned buildings, approximately 3,200 contained asbestos. In 1985, the Kentucky AG's office was among the first in the nation to file a multi–million dollar lawsuit against virtually every major manufacturer, distributor, and other party associated with the installation of asbestos in state–owned buildings. The lawsuit attempts to recover the costs associated with asbestos removal. While the litigation proceeds to a trial date, the AG's office indicates that several manufacturers are now bankrupt. In 1988, the legislature required that state–owned buildings be inspected for the presence of asbestos. Several abatement projects have been conducted or are planned for state–owned schools and office buildings. However, inspections have not been conducted for the majority of state offices.◆

Figure 38
Asbestos Removal Projects in Kentucky



Source: Kentucky Division for Air Quality, 1992

The number of asbestos removal projects in Kentucky have more than doubled in recent years. Asbestos fibers are known to cause disease including lung cancer when breathed into the lungs. About 113 major removal projects were conducted at Kentucky schools during 1991.

Chapter 3

Waste Management

Waste Management

Many human activities generate wastes which require proper disposal to reduce their potential to contaminate the environment. Inadequate waste management in the past has resulted in a number of significant problems that the state must continue to address, including contaminated waste sites, open dumps, and leaking landfills.

Although state and federal regulatory requirements have greatly improved the way most wastes are treated, stored, and disposed, efforts to reduce the amount of hazardous, solid, and radioactive wastes generated in Kentucky are critical to minimize their impacts on health and the environment. Preventing pollution by reducing waste generation, using less toxic substances, recycling, and reusing materials is far more effective than transferring pollutants from one environmental medium to another, which has been the result of many waste control strategies.

This chapter reviews Kentucky's history of hazardous, solid, industrial, special, medical, and radioactive waste management and disposal, as well as the status of contaminated waste sites. Efforts to recycle and reduce the burden of wastes to the environment are also discussed.

Hazardous Wastes

The discovery of the “Valley of the Drums” in 1967 which contained more than 17,000 rusting and leaking drums filled with toxic wastes, emphasized to the nation the risks posed to people and the environment from the generation and improper disposal of hazardous wastes. This site, located near Brooks in Bullitt County, led the state to enact emergency hazardous waste regulations in 1979. State hazardous waste permitting and enforcement programs were later put in place in 1982.

State hazardous waste regulations and programs have evolved since then, and now include monitoring, recordkeeping, emergency planning, closure procedures, and identification and cleanup of waste disposal sites. While these efforts have greatly increased the oversight and management of hazardous waste generated, stored, and disposed by businesses and industries, continued illegal waste dumping and old abandoned sites still pose significant public health and environmental threats throughout the Commonwealth.

This section reviews the status of hazardous waste management in Kentucky including: generation trends; waste reduction efforts; treatment, storage and disposal; waste imports and exports; and state progress in the cleanup of contaminated hazardous waste sites.

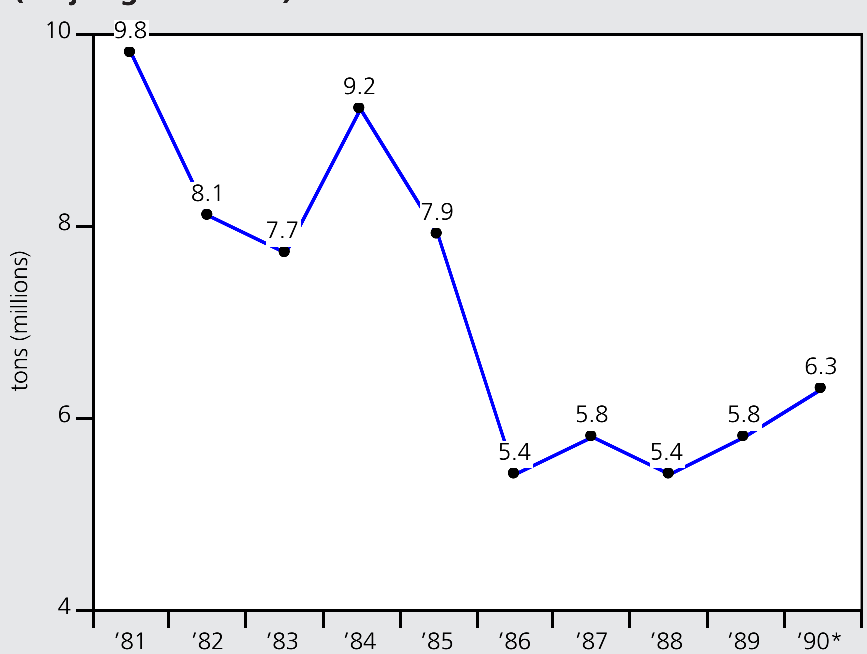
Generation

Hazardous Waste Generation by Major Industries Decreases 36% Since 1981; Most Produced by Ten Sources

Hazardous wastes are those wastes which pose a substantial present or potential hazard to human health or the environment. The U.S. Environmental Protection Agency (EPA) has established criteria and testing methods for hazardous wastes that exhibit characteristics of ignitability, corrosivity, reactivity, or toxicity. Wastes resulting from certain industrial processes, unless exempted, are designated as hazardous and are referred to as "listed" wastes. Hazardous wastes must now be managed according to extensive environmental laws and regulations throughout all stages of generation, storage, transportation, treatment, and disposal. Accidental releases require proper management to minimize any potential harm.

Since 1980, sources which generate hazardous waste in excess of 1,000 kilograms (2,200 pounds) per month, known as full quantity generators, have been required to register and provide annual reports to the Kentucky Division of Waste Management (DWM). Annual generator reports detail the type and amount of hazardous waste produced, the name of the transporter, and the treatment, storage, and disposal facility used. During 1989, the most recent year for which complete data have been compiled, 5.8 million tons of hazardous waste were reported generated by 338 of the 362 full–quantity generators registered in Kentucky **(Figs. 1 & 2)**. Preliminary data indicate that 6.3 million tons of waste were generated in Kentucky during 1990. This represents a reduction of 36% since 1981, when 260 industries generated 9.8 million tons of hazardous waste.

Figure 1
Hazardous Waste Generation in Kentucky (major generators)

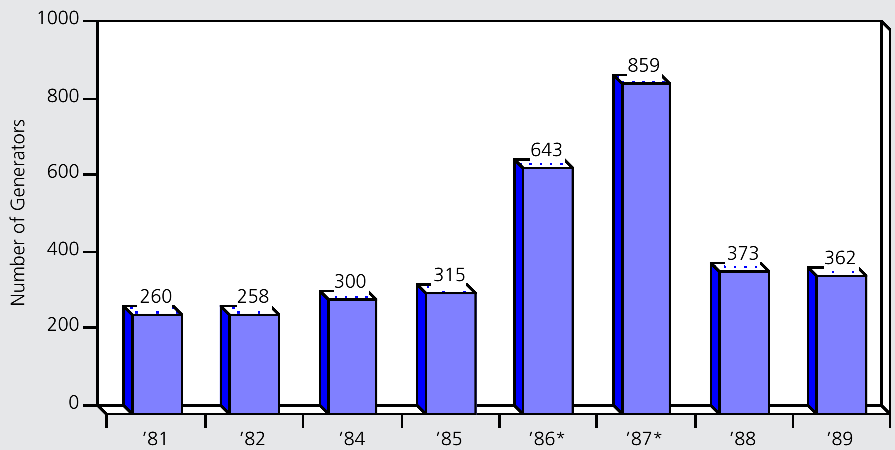


**preliminary data*
Source: Kentucky Division of Waste Management, 1992

Hazardous waste produced by major generators declined in Kentucky between 1981 and 1986, but has increased during the last few years. Hazardous waste produced by smaller generators and households is not factored into these rates and may be as much as waste reported by major generators.

Since 1980, facilities that produce over 2,200 pounds of hazardous waste per month, known as full quantity generators, must register and provide annual reports to the state. In 1989, 338 of the 362 full quantity generators produced 5.8 million tons of hazardous waste.

Figure 2
Full Quantity Hazardous Waste Generators in Kentucky



Note: 1983 data not available. 1989 data most recent available.
** Includes small quantity generators, now managed under a separate program.*
Source: Kentucky Division of Waste Management, 1991

A vast majority of hazardous waste generated in the state during 1989 was produced by ten facilities located in five counties: Marshall, Jefferson, Hancock, Henry, and Union **(Figs. 3 & 4)**. The chemical and allied products industry produced 96% of the state's hazardous waste, followed by the paper industry (3%) and fabricated metals industry (0.1% **(Fig. 5)**. Generator data is based on self–reporting requirements and various assumptions, so it may not necessarily reflect the exact amount of hazardous waste produced in Kentucky by these facilities.

Many Smaller Facilities Also Produce Hazardous Waste; Total May be as Much as Major Sources

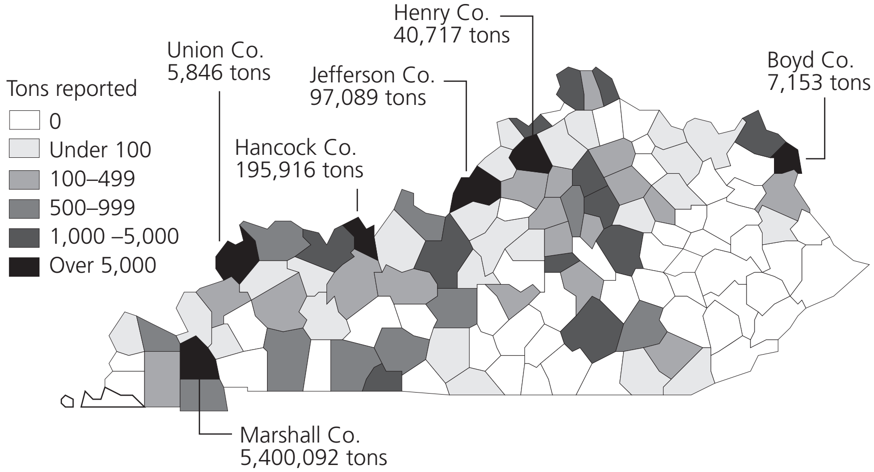
Hazardous waste is also produced by smaller generators. Since 1984, small quantity generators, which are facilities that generate between 100 and 1,000 kg/month (220 to 2,200 pounds), have been required to register with the state. In 1991, there were 570 small quantity generators registered in Kentucky. While 1988 and 1989 state generation data is not available for these sources, 1987 data reveal that 508 small quantity generators produced 14.6 tons of hazardous waste.

Facilities which generate less than 100 kg/month (220 pounds) of hazardous waste per month are known as limited quantity generators. These types of facilities typically include small businesses such as dry cleaners, gas stations, printers, universities, and hospitals. Currently, there are 1,240 limited quantity generators registered in Kentucky. However, as many as 50% of the limited quantity generators producing wastes in Kentucky may not be registered because it is a voluntary program. Therefore, the total amount of hazardous waste generated and disposed by limited quantity generators cannot be definitively determined.

Assessing the total amount of hazardous waste generated in Kentucky is also difficult because of leaks and spills, underreporting by some generators, and because data are not collected from many sources including household hazardous wastes. The U.S. EPA estimates that the amount of non–reported hazardous wastes generated by these sources and others may be as much as that reported by regulated generators.

Major generators reported hazardous waste production in 48 counties. However, hazardous waste is generated by other sources in all counties to some degree.

Figure 3
Reportable Hazardous Waste Generation by County (1989)



Note: 1990 data not available

Source: Kentucky Division of Waste Management, 1991

Approximately 98% of the reported hazardous waste produced in Kentucky during 1989 was generated by ten industries located in five counties.

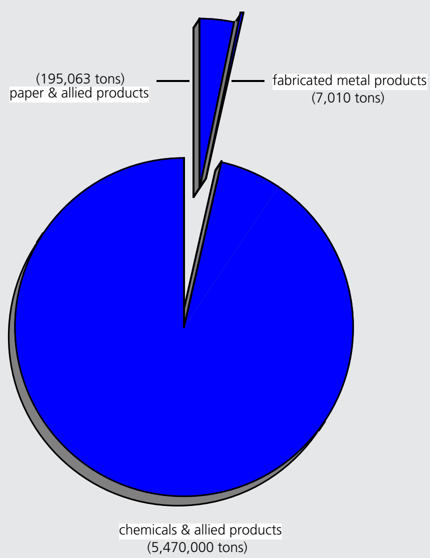
Figure 4
Top Ten Hazardous Waste Generators in Kentucky (1989)

Company	County	Amount (tons)
Atochem	Marshall	4,822,531
B. F. Goodrich	Marshall	564,405
Willamette	Hancock	118,360
Willamette	Hancock	76,001
Safety Kleen	Henry	40,717
E. I. DuPont	Jefferson	23,865
Johnson Controls	Jefferson	23,407
Rohm & Haas	Jefferson	21,521
B. F. Goodrich	Jefferson	9,665
Sheller Globe	Union	5,794
Total 10	**5 counties**	**5,706,266 (tons)**
% total hazardous waste generated in state		**98%**

Note: 1990 data not available

Source: Kentucky Division of Waste Management, Annual Generator Reports, 1991

Figure 5
Major Sources of Hazardous Waste Generated in Kentucky (1989)



Source: Kentucky Divison of Waste Management, 1991

The chemical and allied products industry produced 96% of the hazardous waste generated in Kentucky during 1989. Paper industries produced 3% of the total.

98% of Kentucky's Hazardous Waste is Corrosive Wastewater

While it is important to assess the trends in the total amount of hazardous waste generated from year-to-year, it is just as important to determine its composition and risks. Some wastes are easily treated and safely disposed, while others pose significant risks to exposed persons and the environment.

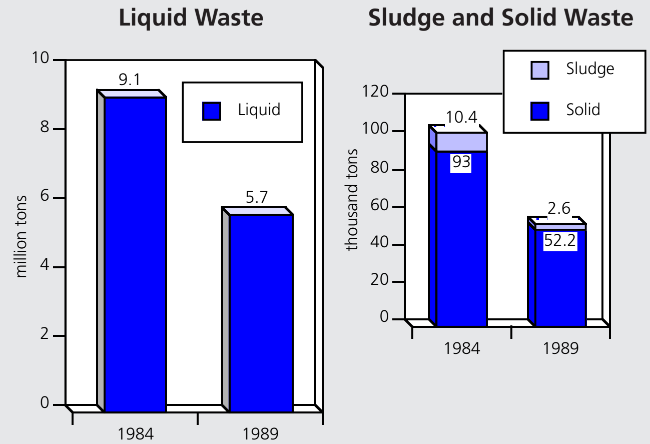
Nearly 98% of the hazardous wastes (5.7 million tons) generated in Kentucky during 1989 was in liquid form, primarily corrosive wastewater **(Fig. 6)**. Most corrosive wastewater was treated on–site and discharged into waterways. DWM reports that these wastes, although greatest in volume, pose relatively little risk when properly managed. Corrosive wastewater is treated prior to its discharge and must meet state water quality standards.

Extremely Toxic Hazardous Wastes Increased 79% Since 1985; Requires More Sophisticated Treatment and Disposal

The remainder of the waste generated in 1989 (approximately 55,000 tons excluding PCBs, asbestos, and waste oil) required more sophisticated treatment and disposal due to its hazardous constituents. These wastes include solvent and sludge wastes, inorganic and organic chemical wastes, toxic hazardous wastes, and many other hazardous chemical wastes. Generation of some of these wastes has been increasing **(Fig. 7)**. For example, the amount of extremely toxic hazardous waste reported to the state increased 79% between 1985 and 1989. Part of this increase is attributed to better reporting by laboratories.

Generation of waste with more than one hazardous characteristic increased 89% during the same five–year reporting period. Again, this increase is likely due in part to better reporting by generators. Reported inorganic and organic chemical wastes and hazardous wastes that are toxic but not considered acutely toxic also increased. Toxic PCBs and asbestos waste generation from reporting sources increased 69% between 1985 and 1989. However, since this type of waste is voluntarily reported, it is difficult to make conclusive yearly comparisons.

Figure 6
Hazardous Waste Generation by Physical State in Kentucky



Note: 1989 data most recent available.
Source: Kentucky Division of Waste Management, 1991

A majority of the wastes generated in Kentucky are in liquid form, the remaining 2% is sludge or solid. The production of these wastes has steadily declined over the years.

Figure 7
Hazardous Waste Generation in Kentucky by Waste Type (tons)

year	corrosive wastewater D wastes	solvent & sludge F wastes	inorganic & organic chemical K wastes	extremely toxic hazardous P wastes	toxic hazardous U wastes	waste that exhibits more than one characteristic	toxic PCB & asbestos wastes	waste oil
1985	6,608,051	23,398	n/a*	195	n/a*	7,701	165,352	n/a*
1987	5,676,694	58,600	76,316	4,239	6,233	27,248	38,866,534	512,112
1989	5,670,662	34,147	11,703	950	9,719	76,115	543,296	412,692
% change (1985–1989)	**–14%**	**+31%**	**–85%**	**+79%**	**+36%**	**+89%**	**+69%**	**–19%**

**1985 data unavailable due to reporting inaccuracies. 1990 data not available.*
Source: Kentucky Division of Waste Management, Annual Generator Reports, 1991

While it is important to assess the trends in the total amount of hazardous waste generated from year-to-year, it is just as important to determine its composition and risks. Nearly 98% of the hazardous waste typically produced in Kentucky is corrosive wastewater which poses relatively little risk when properly treated. The remainder requires more sophisticated treatment because it is of greater hazard.

Treatment, Storage, and Disposal of Hazardous Wastes

91% of Hazardous Waste Generated in Kentucky Neutralized to Render it Non–Hazardous; Incineration of Wastes Increases

Kentucky industries treat the majority of hazardous waste generated to render it legally non–hazardous **(Fig. 8)**. Preliminary 1990 data indicate that 5.5 million tons (87%) of the 6.3 million tons of hazardous waste generated in Kentucky were chemically neutralized and released as permitted discharges to surface streams or impoundments. This represents a 6% increase in the proportion of hazardous waste chemically neutralized since 1984, when 81% of the waste was treated in this manner. Currently, elementary neutralization and wastewater treatment units are exempt from permits, so there are no means to determine how many facilities use the chemical treatment process.

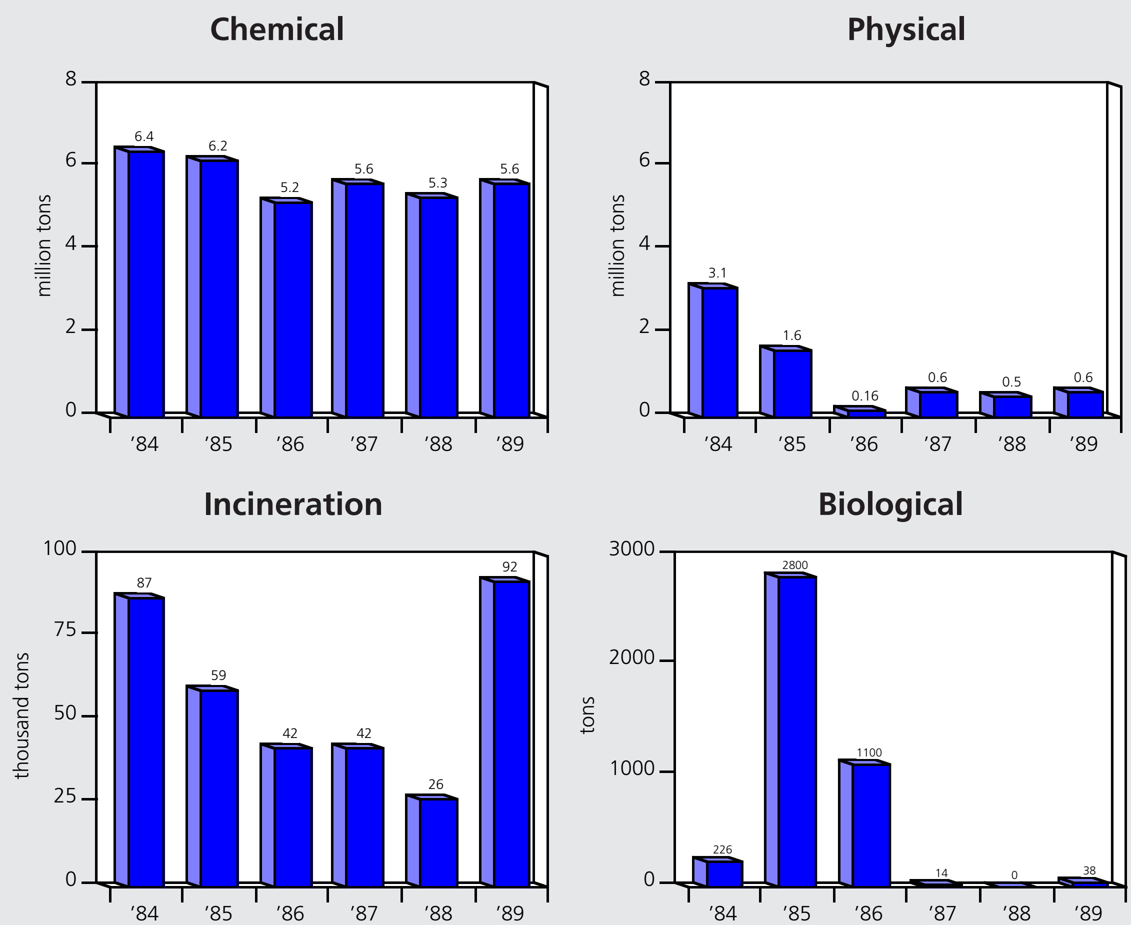
The incineration of hazardous waste is also legally defined as a treatment technology, and not as a method of disposal. During 1989, approximately 93,000 tons of hazardous wastes were incinerated in Kentucky compared to 52,000 tons in 1986. Nearly 28% (25,855 tons) of the hazardous waste incinerated in Kentucky during 1989 was treated at Kentucky's major commercial hazardous waste facility, Liquid Waste Disposal, Inc. (LWD) in Calvert City, according to reports submitted by the company to the Division of Waste Management. The total amount of hazardous waste incinerated in Kentucky during 1990 has not yet been compiled. However, preliminary reports indicate that LWD incinerated 18,691 tons of hazardous waste during 1990. Of this, approximately 12,850 tons (68.7%) were imported from out-of-state generators. LWD reported treating 23,000 tons of out-of-state hazardous waste during 1986.

Currently, there are five hazardous waste incinerators in Kentucky. Four are fully permitted and the LWD facility is operating under interim status. Two facilities, Atochem in Carroll County and Olin in Meade County, operate semi-commercial incinerators which are permitted to receive hazardous waste from off–site generators. The two other incinerators, Atochem in Marshall County and DuPont in Jefferson County, burn hazardous waste generated on–site. The LWD incinerator in Calvert City is currently operating under interim status through an Agreed Order. The state’s decision to deny this company’s permit based on past performance was effective September 1990. The company legally challenged the decision and the court has allowed the facility to continue operations pending action or settlement of the lawsuit. The state is currently reconsidering denial of the LWD permit pending review of test burns at two existing incinerators and a third new unit at the facility. The incinerator failed two previous test burns. The trial burns test the units' efficiency to burn 99.99% of the waste to be incinerated.

During 1989, 607,000 tons of hazardous waste generated in Kentucky were physically treated before disposal. Physical treatment primarily includes distillation and fuel blending, as well as sedimentation to separate hazardous waste constituents. This is a significant decrease since 1984 when 3.1 million tons were treated in this manner. This decrease is due to the closing of 24 surface impoundments and the shift toward chemical treatment.

Biological treatment of hazardous waste decreased from a high of 2,800 tons in 1985, to 38 tons in 1989. Biological treatment is infrequently used in Kentucky because it is usually ineffective for treating concentrated hazardous wastes.

Figure 8
Hazardous Waste Treatment in Kentucky



Note: 1989 data most recent available.

Source: Kentucky Division of Waste Management, 1991

Kentucky industries treat a majority of the hazardous waste produced to render it legally non–hazardous. Nearly 96% of the waste treated in 1989 was chemically neutralized. Other wastes were physically treated through distillation, fuel blending, or incinerated.

70,000 Weapons Containing Nerve Gas Stored at Lexington-Bluegrass Army Depot; Army Proposes Incineration

Approximately 70,000 obsolete rockets filled with lethal nerve gas are stored at the Lexington Bluegrass Army Depot (LBAD) near Richmond in Madison County. National legislation was passed in 1985 requiring the entire continental U.S. stockpile of these weapons to be destroyed by September 1994, although the deadline has been extended to April 1997.

The U.S. Army has proposed to construct an on-site incinerator at LBAD to destroy the weapons stored in Kentucky. (The LBAD stockpile represents 1.6% of the nation's nerve gas weapons.) Opposition to the Army's plan has been voiced by numerous city and county government officials, environmental organizations, concerned citizens, and independent consultants hired to review the Army's plan. The primary concerns include the inadequacy of the environmental impact statement prepared by the Army regarding the potential human health and environmental effects associated with incinerating the nerve gas and the Army's inability to demonstrate that their chosen disposal method is safe.

Safety is of high concern because the area is densely populated and there are schools in the immediate vicinity. A citizen's conference was held in November 1991, following a public hearing in April. Recommendations included the need for a full review of alternatives to incineration, including chemical neutralization.

The first phase of the site-specific environmental impact statement was due November 1991, but the Army failed to meet that schedule and is behind in releasing other documentation as well. The army submitted a hazardous waste permit application for the proposed incinerator in October 1986, which is required because the disposal of nerve gas is regulated as a hazardous waste in Kentucky. The application was rejected by the state Cabinet for Natural Resources and Environmental Protection as deficient. The Army plans to resubmit the hazardous waste permit and an air permit application in June 1992.

The Army will also be required to meet more state stringent requirements passed in the 1992 General Assembly. The law will require the Army to prove there is no feasible alternative to incineration and ensure "consistent" destruction of the nerve gas agents prior to the issuance of a state permit.

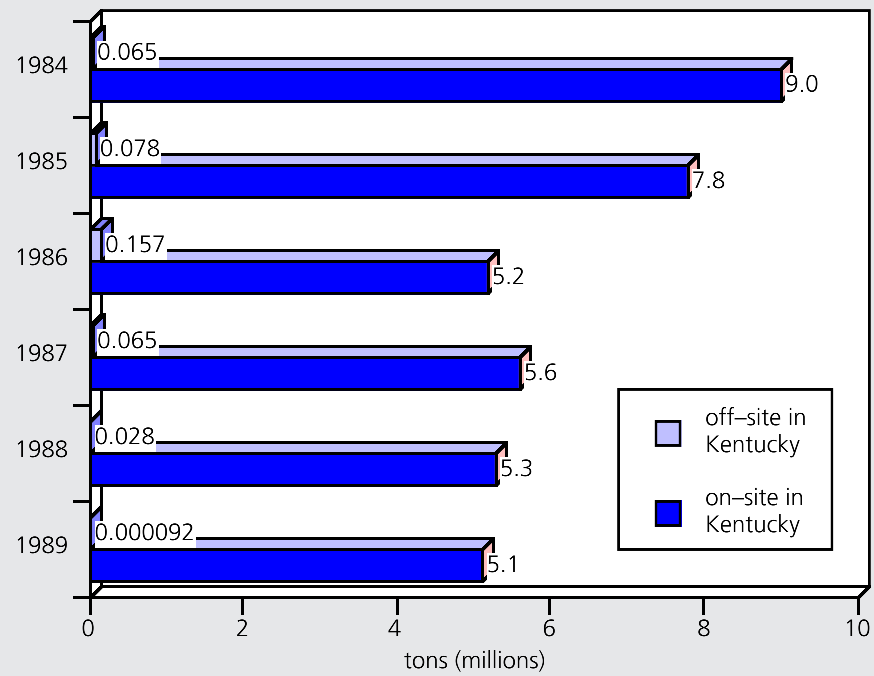
Majority of Hazardous Waste Generated in Kentucky Treated On–Site; Two Landfills Permitted to Accept Waste

Most hazardous wastes generated in Kentucky are treated prior to disposal to minimize their impact to the environment. During 1989, 5.1 tons of hazardous waste generated in Kentucky were treated and disposed on–site **(Figs. 9 and 10)**. Most of this waste was disposed in surface impoundments. This method of disposal increased significantly from 275,000 tons in 1986, to 4.8 million tons in 1989. This increase, however, was primarily due to a regulatory redesignation of surface impoundments from treatment to disposal facilities. All 24 surface impoundments are now closed. Eleven of the sites closed as landfills, rather than storage facilities, because of the inability to remove all contamination.

Most of this waste is now stored in above–ground tanks, treated, and discharged under conditions specified in state water permits or transferred off–site for treatment or disposal. The state requires facilities to obtain waste storage permits when hazardous wastes are stored on–site for more than 90 days by full quantity generators, and if stored more than 180 days by limited quantity operations. There are 20 hazardous waste storage facilities currently permitted in Kentucky.

Some hazardous wastes are also landfilled on–site in Kentucky. Currently, DWM permits two industrial on–site hazardous waste landfills operated by Ashland Oil in Boyd County and Newport Steel in Campbell County. The amount of hazardous wastes received at these landfills has decreased from a high of 127,000 tons in 1986, to a low of 28 tons in 1989.

Figure 9
Hazardous Waste Treatment and Disposal in Kentucky



Note: 1989 data most recent available.
Source: Kentucky Division of Waste Management, 1991

Most hazardous waste generated in Kentucky is treated and disposed at the site where it was produced. The remainder is shipped to other in–state facilities for treatment and disposal, or sent out–of–state for disposal.

Fuel Blending and Burning Used for Hazardous Waste Disposal in Kentucky; Two Hazardous Waste Injection Wells Permitted in Louisville

Another method of disposing hazardous waste, particularly spent solvents, is to blend the wastes and burn them for fuel. Although this process decreases disposal needs, it may result in an increase in the release of toxic air emissions. Facilities that burn blended wastes are not required to be permitted by the Division for Air Quality, although the Division does authorize them to burn these wastes on a case–by–case basis. Safety Kleen, a commercial facility in Henry County, distills and blends waste solvents and other hazardous wastes for resale as fuel. The company has four other facilities which serve as collection centers.

Several facilities accept hazardous waste from out–of–state for these purposes. The amount of hazardous wastes burned as fuel cannot be accurately determined because full reporting is not required. However, at least 36.1 million pounds of out–of–state hazardous waste were burned at one Kentucky facility alone in 1990.

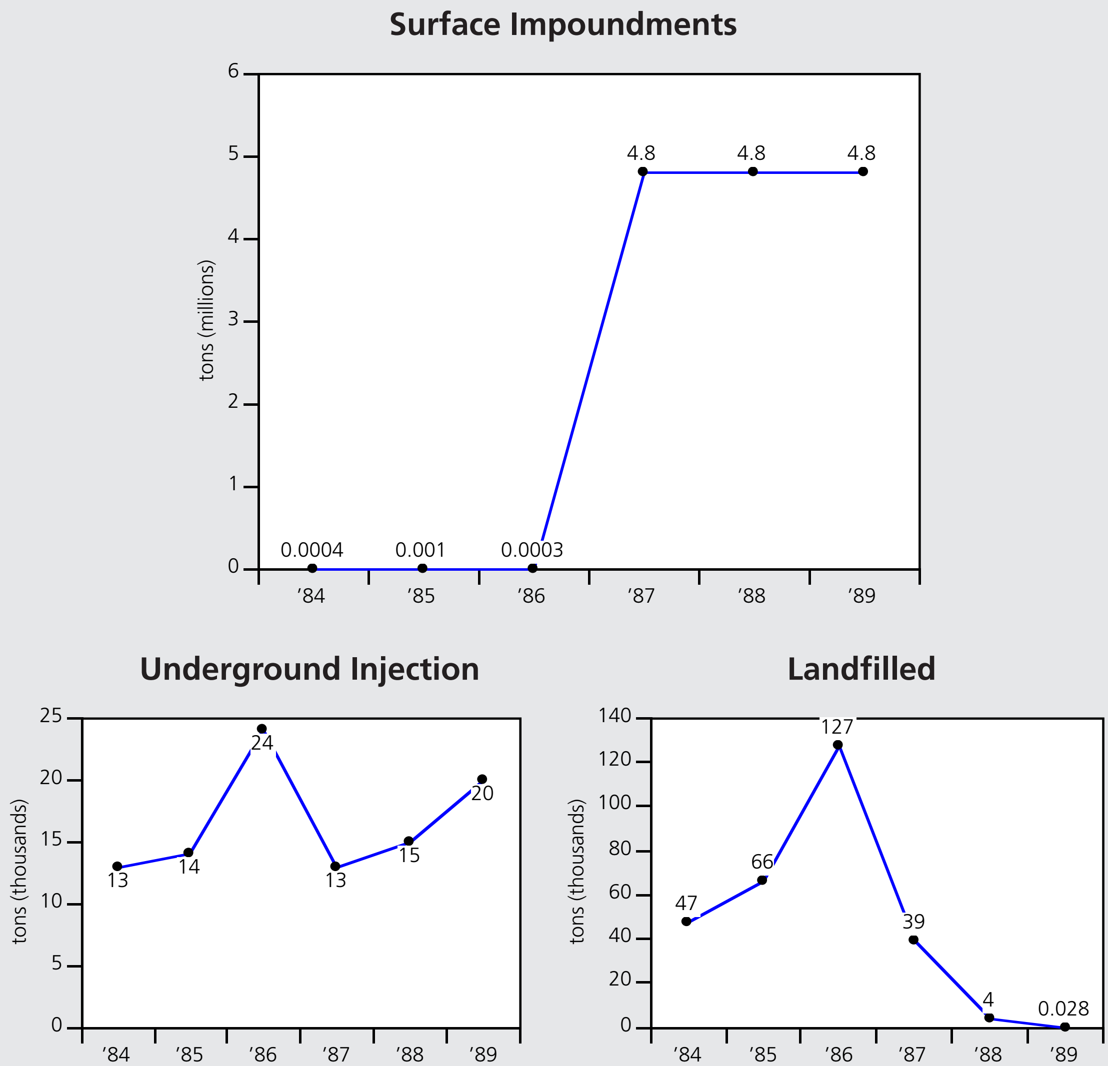
In 1989, approximately 20,000 tons of hazardous waste were disposed in Kentucky through underground injection wells. Although it is generally assumed that this practice poses little threat because wells are required to be drilled below drinking water sources, the U.S. EPA is phasing out the use of underground hazardous waste injection wells because of the potential risks this practice poses to groundwater.

The U.S. EPA currently permits two underground injection wells for hazardous waste disposal in Kentucky at DuPont Chemical in Louisville. The company has been permitted since 1973 to inject 80 million pounds of dryweight hydrochloric acid a year until its permit expires in 2000. In 1988, DuPont injected 30 million pounds of acid. In 1990, the company found a market for its waste and reduced injection of these wastes to 9.4 million pounds. DuPont has indicated to the U.S. EPA that they plan to discontinue using at least one well by early 1993, as a result of waste reduction efforts.

Most of the hazardous waste generated in Kentucky was disposed in surface impoundments. All surface impoundments were closed in 1989 and wastes are now stored in above ground tanks and treated. There are two underground injection wells and two on–site industrial landfills located in Kentucky for the disposal of hazardous wastes generated in the state.

Figure 10

Hazardous Waste Disposal in Kentucky



Note: 1989 data most recent available.

Source: Kentucky Division of Waste Management, 1991

Enforcement

Enforcement Acitivities Focus on Illegal Treatment, Storage, and Disposal Facilities

DWM currently permits 91 hazardous waste treatment, storage, and disposal (TSD) facilities **(Fig. 11)**. Five facilities are operating under interim status permits with the remainder fully permitted. The U.S. EPA has criticized the state for not adequately inspecting and enforcing laws at TSD facilities. But the state contends that all permitted facilities receive adequate oversight. While the number of state hazardous waste inspections declined during recent years, the citing of violations nearly doubled since 1985 **(Fig. 12)**. The collection of penalties and number of enforcement cases also increased significantly between 1989 and 1990.

The most common violations of state hazardous waste laws and regulations include:

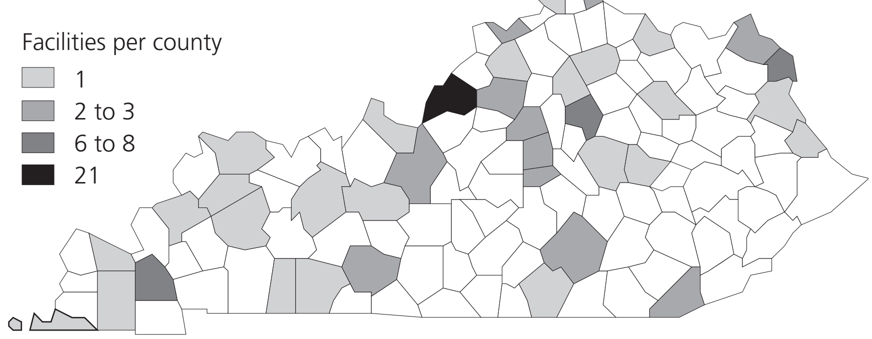
- Accumulation of hazardous waste beyond the regulatory time frame;
- Failure to properly manage and maintain waste containers;
- Treatment, storage, or disposal without a permit;
- Failure to register a hazardous waste;
- Failure to use or properly complete manifests;
- Failure to make a determination of whether or not a waste is hazardous;
- Failure to have sudden or non–sudden liability insurance;
- Failure to report a release of hazardous substances, pollutants, or contaminants; and
- Failure to restore the environment following a release of hazardous pollutants/ contaminants.

Improper waste management occurs most often at unpermitted facilities, according to DWM. State officials report that these illegal sites also pose the greatest enforcement problems. Illegal facilities often use lengthy court battles to stall efforts to bring them into compliance with the laws. Currently, 26 hazardous waste facilities are under enforcement actions because they failed to notify the state of their activities as required by law. These include: 12 illegally operated landfills, ten hazardous waste storage and treatment facilities, 11 full–quantity generators, two small quantity generators, and one illegal transporter. DWM suspects there are many more illegal facilities operating in the state and has focused enforcement efforts to locate these sites.

The extent of contamination at the 91 facilities permitted in Kentucky to treat, store, or dispose hazardous wastes is not well known. New federal requirements will require assessments to determine contamination. Of the 44 assessments conducted so far, 33 facilities have potential contamination problems.

Figure 11

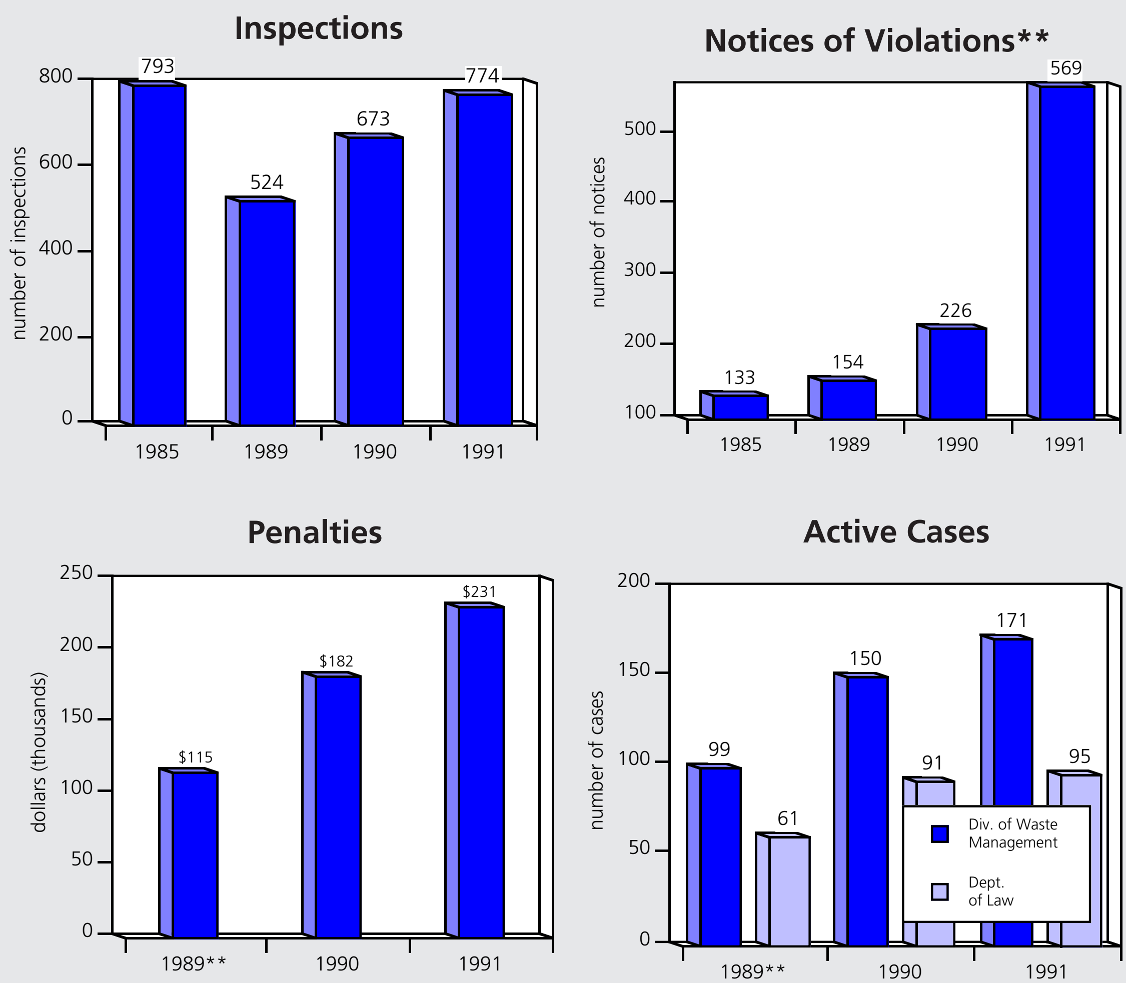
Hazardous Waste Treatment, Storage, and Disposal Facilities



Source: Kentucky Division of Waste Management, 1991

The number of state hazardous waste violation notices issued and penalty assessments have increased in recent years. Enforcement actions have focused on illegal facilities. Twenty-six facilities are currently under enforcement action for illegal operations.

Figure 12
State Hazardous Waste Enforcement Activities*



**By fiscal year (July 1–June 30)*
***A Notice of Violation may include several violations of environmental regulations.*
****Earlier data not available*
Source: Kentucky Division of Waste Management,Field Operations and Enforcement Branch; Department of Law, 1992

Potential Problems Identified at 33 of 44 Hazardous Waste Facilities Reviewed by the State

The extent of contamination occurring at sites where facilities treat, store, or dispose of hazardous waste, is not well known. Federal regulations now require these hazardous waste facilities to assess potential contamination from landfills, underground storage tanks, and other activities to determine whether contamination is present. Corrective action plans must be developed when problems are discovered.

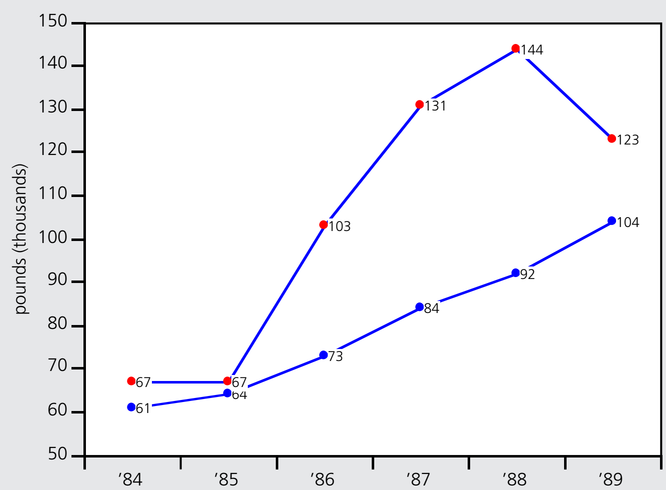
During 1990 and 1991, DWM conducted 44 assessments at TSD facilities with pending permits or closure plans. Potential contamination has been identified at 33 of the 44 facilities. Many facilities will be required to institute a number of corrective actions because of the existence of numerous potentially contaminated areas. Contaminated areas at facilities are known as a Solid Waste Management Units (SWMUs), and usually include landfills, surface impoundments, lagoons, and underground storage tanks. Examples of TSD facilities with documented SWMUs include: the U.S. Department of Energy Gaseous Diffusion Plant at Paducah which has 164, Atochem in Calvert City with 70, the Bluegrass Army Depot outside of Lexington has 49, and B. F. Goodrich in Marshall County has 128 SWMUs, based on the assessments. All will require further investigation. The state will be reviewing other TSD facilities as federal requirements take effect.

Hazardous Waste Disposal Capacity

Hazardous Waste Exported from Kentucky Decreasing, Imports Increasing; Disposal Capacity Estimated at 27 Million Tons

Kentucky, like most states, relies on facilities located both inside and outside its borders for the disposal of hazardous wastes. During 1989, Kentucky generators exported 123,305 tons of hazardous wastes to other states for disposal. Kentucky ships waste to Indiana, Ohio, Alabama, Louisiana, Michigan, New Jersey, and other states. In comparison, about 104,114 tons of hazardous waste were imported into the state from Ohio, Illinois, Indiana, New York, Mississippi, and other states. These wastes were primarily imported from industrial facilities affiliated with Kentucky companies. Trends show that hazardous waste exports are decreasing and imports are increasing in Kentucky **(Fig. 13)**.

Figure 13
Hazardous Waste Imports and Exports in Kentucky



Note: 1989 data most recent available.

Source: Kentucky Division of Waste Management, 1991

Hazardous waste generated in Kentucky and exported to other states for disposal steadily increased until 1988. In 1989, exports declined about 14%. Hazardous waste imported into Kentucky from other states for disposal continues to increase.

Hazardous waste disposal capacity is declining nationwide. In addition, some states with hazardous waste landfills have sought to ban out–of–state hazardous waste shipments into their states. To ensure disposal capacity for hazardous waste, in 1989 Congress required all states to assess their hazardous waste disposal needs and demonstrate disposal capacity for the next 20 years.

Kentucky's 1989 assessment, known as the "Capacity Assurance Plan," indicated that the state had approximately 27 million tons of hazardous waste disposal capacity. A majority of that capacity is located on–site at facilities which generate wastes. The state has limited disposal capacity at commercial facilities (70,000 tons) and has no commercial hazardous waste landfill. A report prepared for the National Governor's Association (NGA), indicating that Kentucky is a net exporter of hazardous waste, could be misinterpreted since the state only exports about 2% of all hazardous waste generated. Twenty of the 36 other net exporting states export a higher percentage of their generated waste than does Kentucky.

In 1989, the state entered into an interstate compact with Alabama, South Carolina, and Tennessee to provide reciprocal disposal of hazardous waste. Environmental groups in Kentucky, however, have voiced concern that the NGA report and the state's capacity plan are providing an inaccurate picture of Kentucky's hazardous waste imports and exports.

A more thorough analyses of state hazardous waste imports and exports as well as hazardous waste disposal capacity needs to be undertaken. Among the wastes not factored into Kentucky's plan that should be considered are exported and imported hazardous wastes which are stored and then disposed, and wastes that are burned or blended for fuel. The state capacity plan did not recommend that Kentucky site new disposal facilities, but rather promotes waste reduction at the source.

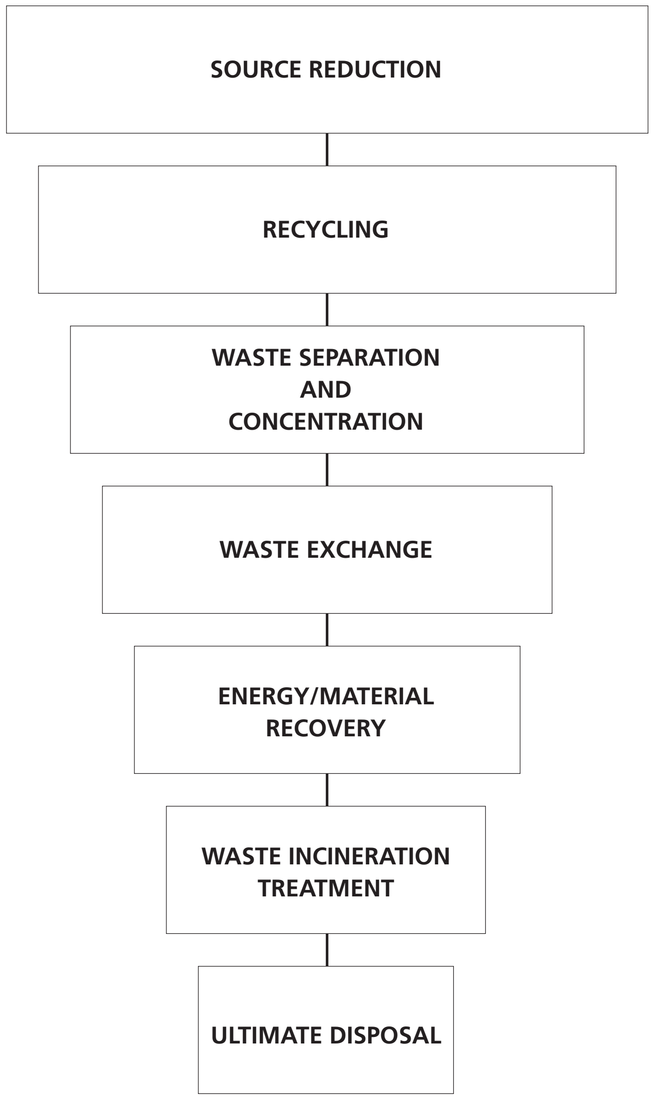
Waste Reduction

Major Sources Required to Reduce Generation of Hazardous Wastes to the Extent Economically Feasible

Nationally, as well as in Kentucky, the primary approach to minimizing the impact of hazardous wastes in the environment has revolved around "end of pipe" controls, which focus on treatment and management of wastes prior to final disposal. This approach provided much–needed improvements, offering protection from direct dumping and uncontrolled releases. State hazardous waste programs were developed for the purpose of issuing permits, providing technical assistance, enforcing environmental laws, and ensuring that wastes are managed correctly. However, most hazardous waste controls simply transfer contaminants from one environmental medium to another. For example, landfilling hazardous waste has resulted in the transfer of pollutants to groundwater. Incineration releases pollutants into the air and produces hazardous sludge residues which require disposal.

Increasing evidence of the impact of pollutant transfer, which often results in the concentration of contaminants in a particular medium, prompted Congress to enact the Pollution Prevention Act of 1990. The act requires the U.S. EPA to take a new approach to protecting the environment through stronger emphasis on pollution prevention at the source of waste generation. According to the National Association of Manufacturers, waste reduction is a "method of pollution prevention that focuses on reducing the generation and discharge of hazardous waste at its source to avoid subsequent handling, treatment, and disposal." Major hazardous waste sources are now required to implement waste reduction, preferably source reduction, to the extent economically feasible **(Fig. 14)**.

Figure 14
Hazardous Waste Management Priorities



Source: U. S. Environmental Protection Agency, 1990

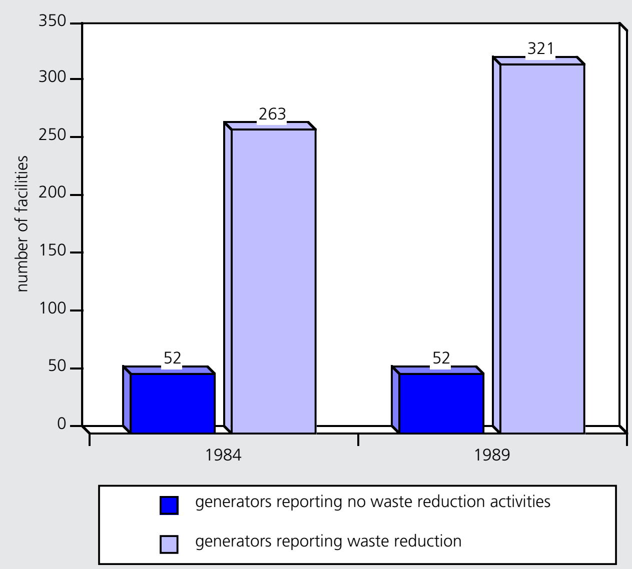
The U.S. Congress has recently focused on reducing the amount of hazardous waste produced. This hierarchy of waste management is being promoted nationwide. Industrial facilities are now required to implement waste reduction to the extent economically feasible.

Recycling, Solvent Recovery, Incineration Most Often Cited Waste Reduction Measures in Kentucky

Determining the feasibility and need for waste reduction has generally been left up to individual generators under Kentucky's waste reduction regulations. Waste generators must provide a statement describing their efforts to reduce waste volume and toxicity as part of DWM's annual reporting requirements. During 1989, 88% of the state's full quantity hazardous waste generators reported waste reduction measures, a slight increase from 1984 when 83% reported reduction activities **(Fig. 15)**. The 1989 reports also show that 32% of the generators most often cited changes in production process or equipment as their primary waste reduction method. Other measures included: on–site recycling (13%), off–site recycling (13%), solvent recovery (10%), incineration (10%), and materials substitution (9%) **(Fig. 16)**.

Some companies have made investments and demonstrated a commitment to reducing hazardous waste. For example, both the Elizabethtown and Carrollton Dow Corning plants have made efforts to reduce hazardous waste generation and toxic emissions. Plant officials say the company recognized that significant waste reduction, during a time of increased production, could only be accomplished through reduction at the source. Using a team strategy that involved all employees, the company set goals for achieving a 20% yearly reduction during the years 1989 through 1993 for hazardous waste generation, toxic emissions of 1,1,1 trichloroethane, solid waste disposed in landfills, and the amount of process waste produced as a percent of production at the Elizabethtown facility. All these goals have been met or exceeded and the company reports impressive savings from these efforts. Hazardous wastes have been reduced at the plant 70%, and 1,1,1 trichloroethane emissions were reduced by more than 90%. Similar results have been achieved at the Carrollton facility where hazardous wastes have been reduced 42%, methyl chloride emissions by 94%, and a 100% reduction in toluene emissions has been achieved in addition to other reductions since 1987.

Figure 15
Hazardous Waste Reduction Activities in Kentucky



Note: 1989 data most recent available.
Source: Kentucky Division of Waste Management Quarterly Reports, 1984 and 1988

Beginning in 1984, hazardous waste generators in Kentucky were required to conduct waste minimization activities. During 1989, 88% of the full quantity generators reported various waste reduction measures.

Figure 16
Hazardous Waste Minimization Activities Reported by Major Generators in Kentucky

Waste Minimization Activities	number of facilities reporting 1986	1987	1988	1989
recycled on–site	23	14	15	43
recycled off–site contractors	150	76	36	41
change in production process or equipment	91	114	72	110
materials substitution	56	79	47	32
extended use of materials	8	12	10	30
change in inventory management	6	9	1	10
reused waste in process	28	18	25	21
employee training	8	17	10	20
waste concentration	50	0	0	27
recycled as fuel or for heat recovery	7	13	22	3
incineration	104	84	49	34
solvent recovery or distillation	229	189	58	35
metals recovery or reclamation	14	20	11	3
electroplating recovery unit	1	0	0	1
dewater sludges or filter press	21	16	7	7
recycled to low quality paint	1	0	0	0
recycled wastewater	2	0	0	0
neutralization	22	29	16	8
cyanide destruction	3	1	0	0
filtration	3	2	1	0
reduction of tank reels from trucks	1	3	0	4
waste exchange	0	2	1	0
no plans	5	51	34	49
minimization program planned or proposed	16	15	6	24
other	47	96	53	0
not applicable for valid reason	55	83	24	11
not answered	8	47	4	17

Note: 1989 data most recent available.

Source: Kentucky Division of Waste Management, Annual Generator Reports, 1986-1989

Many of the state's major generators have been relying on treatment, such as incineration and underground injection, as part of their waste reduction strategies. Whether these technologies qualify as waste reduction has been questioned. Additional reductions will require a concerted state effort and a goal by which progress can be measured.

Hazardous Waste Reduction Efforts of Ten Major Generators in Kentucky Varied; One Facility Reports No Plan

The annual reports of the top ten hazardous waste generators in Kentucky for 1988, 1989, and 1990 (preliminary) were reviewed to determine if significant waste reductions are being achieved. Since these ten facilities account for 98% of the hazardous waste generated, their minimization efforts will largely determine the state's progress in reducing both the volume and toxicity of hazardous waste generated and disposed.

In 1988, the waste reduction reports from these generators showed the following:

- Six of the ten generators gave no meaningful description or measurement of reductions.
- One generator reported no waste minimization plan or effort.
- Four of the nine reporting waste minimization cited incineration or underground injection as a large part of their waste reduction strategy.
- Three generators provided statements indicating they were attempting comprehensive waste reduction through changing their processing and the use of some materials.

During 1989, these ten facilities reported the following:

- Facilities reporting quantitative reductions did so by using incineration or chemical treatment as their primary form of waste reduction.
- The facility that reported no efforts in 1988, also reported none in 1989.
- Four facilities reported reduction information nearly identical to the 1988 report and two provided exactly the same statement as in 1988.
- One facility used the services of the Kentucky Partners program to study reduction potential.

A cursory review of preliminary 1990 reports from these generators showed that many provided no meaningful information regarding waste minimization progress. One facility indicated that it sent nearly four times as much waste off–site for incineration as one of its primary waste reduction efforts. Several facilities provided statements that were essentially identical to those submitted in previous years. The generator reporting no efforts to minimize waste in previous years also reported none in 1990.

While there have been commendable efforts by some industries to reduce the generation of waste, several facilities have cited incineration or off–site transfers, as their primary waste reduction methods. Whether these technologies qualify as waste reduction is questionable. Because treatment is generally cheaper than re–equipping facilities to minimize wastes, it is not likely that larger generators will achieve significant voluntary reductions in their production of hazardous wastes without additional incentives or disincentives.

Waste Minimization Centers Assist Industries with Reductions; Incentives Needed to Encourage Additional Waste Reduction

Kentucky established a waste minimization center at the University of Louisville to assist businesses with waste reduction methods. Since 1988, the Kentucky Partners Pollution Prevention Program has assisted 60 industries in conducting environmental audits and identifying options for waste reduction and minimization. Another prevention program, the Waste Minimization Center, was established by the U.S. EPA and is also located at the University of Louisville. The Center has helped several businesses reduce wastes. One manufacturing company achieved a $65,000 per year savings after initiating changes that reduced liquid hazardous waste generation by 71% and decreased solid waste generation by 84%. The company was also able to reduce raw material purchases by 50%.

While efforts to reduce and minimize wastes have progressed over the past few years, incentives or requirements may be needed to encourage additional waste reduction efforts.

Measures to Overcome Barriers to New Waste Reduction Technologies Needed

It appears that regulatory inflexibility may be impeding some efforts to reduce hazardous wastes. For example, Akzo Coatings, Inc. of Kentucky attempted to initiate a waste reduction and solvent recovery program by developing an innovative technology to recycle and recover its wastes. The company believed this technology would eliminate transportation of all hazardous waste shipped off–site, in addition to reducing liability for wastes which must be disposed.

Because this approach involves a new technology that has not been addressed by present regulations, the company has faced delays in obtaining the hazardous waste permit exemption needed to assess its feasibility. Both U.S. EPA and Kentucky DWM have indicated that the company should seek a Research and Development permit, which requires a longer and more complex process to implement the technology. The company asserts that the permitting requirements have caused counterproductive delays and additional costs which actually discourage efforts to reduce industrial wastes. The U.S. EPA contends, however, that regulatory controls, such as the requirement to obtain a permit and keep the public informed of hazardous waste management activities, are necessary to protect the environment from new technologies which have never been practically tested outside laboratories. At present, the company is conducting small scale–demonstration projects at the University of Louisville and plans to resubmit an application for a permit exemption.

Additional hazardous waste reduction will require a concerted state effort and goals by which progress can be measured. A careful balance between the need to regulate management activities and the need to encourage innovative technology that promotes waste reduction must also be achieved.

Contaminated Waste Sites

In Kentucky, there are hundreds of abandoned hazardous waste sites posing a significant threat to the environment from contaminants leaking into the land, air, and water. The investigation and cleanup of abandoned hazardous waste sites is primarily the responsibility of DWM which conducts initial investigations and preliminary assessments of potential sites.

Sites that are highly contaminated, or pose an immediate threat, may be proposed for inclusion on the U.S. EPA's National Priority List (NPL), better known as Superfund. If included on the list, the U.S. EPA assumes primary authority for management of the site and the cleanup process. However, relatively few of the contaminated sites nationwide are considered to be in such serious condition to warrant takeover by the U.S. EPA. Contaminated sites that do not qualify for Superfund status, become the state's responsibility to oversee site assessment, cleanup, and future monitoring.

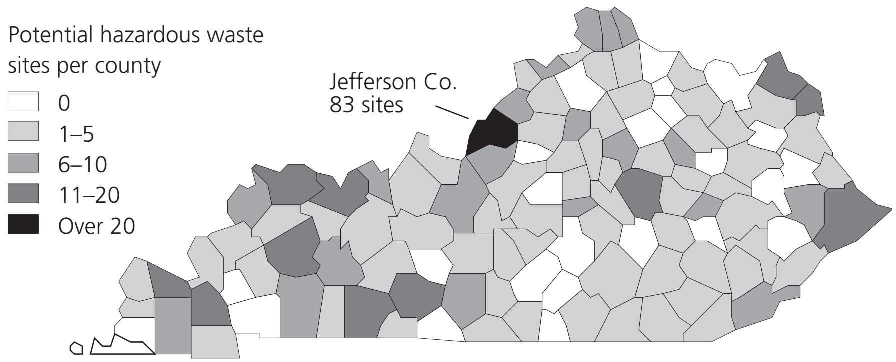
536 Potential Waste Sites in Kentucky; 254 Sites Investigated, Contamination Detected at 181

More than 536 potential hazardous waste sites have been identified in Kentucky, and the number grows yearly by 40 to 50 sites. Of the 254 waste sites investigated, 181 (71%) have some degree of contamination detected. Contaminated groundwater has been detected at 91 of the sites, surface water pollution at 36 sites, and 82 sites have soil contamination **(Fig. 17)**. The status of the cleanup at the 181 contaminated sites is difficult to assess because the state has not comprehensively compiled this data. During 1990, DWM developed remediation plans for five sites where no responsible party could be determined or located. Cleanup plans proposed by responsible parties were approved by the state and the U.S. EPA for 17 other sites.

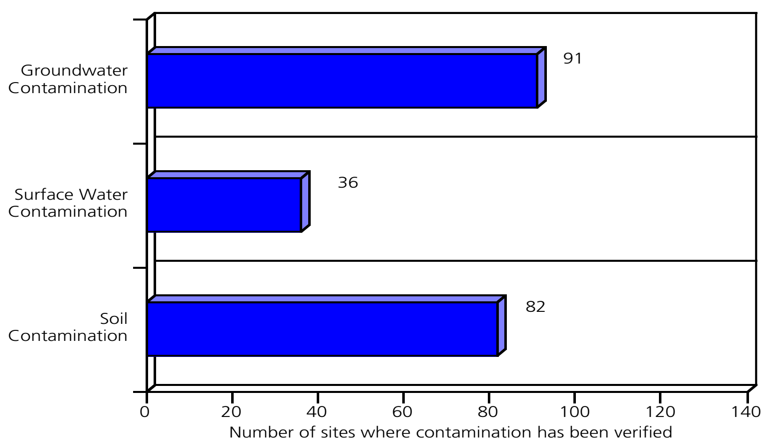
There are 536 potential hazardous waste sites in Kentucky. To date, 254 have been investigated and contamination has been detected at 181 sites. About 40 potential waste sites are discovered each year in Kentucky.

Figure 17

Hazardous Waste Sites (Potential) in Kentucky



Contamination Detected at Hazardous Waste Sites



Source: Kentucky Division of Waste Management, 1991

The costs of cleaning up hazardous waste sites are significant. The average cost to remediate a contaminated site is estimated at $4 million. Kentucky must often rely on enforcement actions to force individuals or companies to clean up sites. The U.S. EPA has used federal emergency waste removal funds in instances where there is an acute threat to public health or the environment. Since 1981, over 75 emergency actions have been conducted in Kentucky, an average of six each year. The estimated cost of a removal operation is $300,000. The state is not required to match the costs associated with federal emergency removal actions. The U.S. EPA does seek cost reimbursement from responsible parties.

Cleanup of Kentucky's 17 Superfund Sites Slow; Some Remediation Strategies Questioned

Sites posing serious health and environmental risks may qualify for federal Superfund money. The purpose of the Superfund program is to provide a source of funds to address sites when responsible parties are either not available to correct the environmental problems, or are unwilling to cooperate. Currently, there are 1,236 sites on the Superfund National Priority List nationwide. Only 29 Superfund waste sites have been addressed and subsequently deleted from the list. Nationally, the projected number of high priority sites requiring action is expected to grow to well over 2,000 by the turn of the century.

Kentucky has 17 sites presently included on the national Superfund list **(Fig. 18)**. Two additional sites, the Dayhoit/Cooper Industry site in Harlan County and the National Southwire Aluminum Plant in Hancock County, were also proposed for inclusion in 1991. The U.S. EPA is also studying the Industrial Waste Haulers site in Elizabethtown to determine if the site qualifies for Superfund listing. Three of Kentucky's Superfund sites have been declared "clean" by the U.S. EPA but have yet to be delisted. They are the Newport Landfill in Campbell County, Valley of the Drums (A.L. Taylor) in Bullitt County, and Lee's Lane Landfill in Jefferson County.

Kentucky's other Superfund sites are in various stages of study or remediation. Technical complexities, along with difficulty in locating responsible parties and negotiating settlements make the cleanup of these waste sites a long–term process. In some cases, responsible parties have agreed through voluntary settlements with the U.S. EPA, to take remedial action at sites. Responsible parties have agreed to remediate eight of Kentucky's 17 Superfund sites.

The U.S. EPA has been criticized by Congress for selecting less stringent cleanup remedies to obtain negotiated settlements with responsible parties. The state has questioned the U.S. EPA's proposed cleanup alternatives at four of the Kentucky Superfund sites: B. F. Goodrich, Airco, Smith's Farm, and Howe Valley, citing concerns that the strategies provide inadequate protection of public health and the environment.

Eight Kentucky Superfund sites have received, or are scheduled to receive, federal Superfund dollars. The average cost for the cleanup of a Superfund site is estimated at almost $25 million. The state will be required to match 10% of the costs and must pay for the long–term care of Superfund sites as well. This includes groundwater monitoring and site maintenance when responsible parties are not available. Kentucky has joined with other states in challenging the U.S. EPA's interpretation that requires states to pay the full operation and maintenance costs for 30 years, beyond the first year, at Superfund sites.

State Fund to Clean Up Waste Sites Insufficient; Estimated to Raise $2 Million Annually

Kentucky's Superfund sites are a sobering reminder of the costs and dangers these waste sites pose to both public health and the environment. In 1981, a state hazardous waste fund was established to help finance the cleanup of hazardous waste sites **(Fig. 19)**. The fund is financed through fees assessed on hazardous waste generated or managed in Kentucky. Kentucky lawmakers increased the hazardous waste generator fee from one to five cents per gallon, depending on disposal method, to ten cents per gallon, and from $2.50 to $5 per cubic yard during the 1990 legislative session.

The fund will be used to finance the state's share of costs for Kentucky Superfund cleanups and to remediate other sites overseen by the state. Funding necessary to provide the required 10% match for Superfund sites alone is estimated at $18 million over the next ten years. Between 1982 and 1990, the Kentucky Hazardous Waste Management Fund raised an estimated $5.1 million, far less than is needed to meet the required state match. Much of the fund is encumbered for Superfund cleanups.

Figure 18
Kentucky Superfund Sites and Status

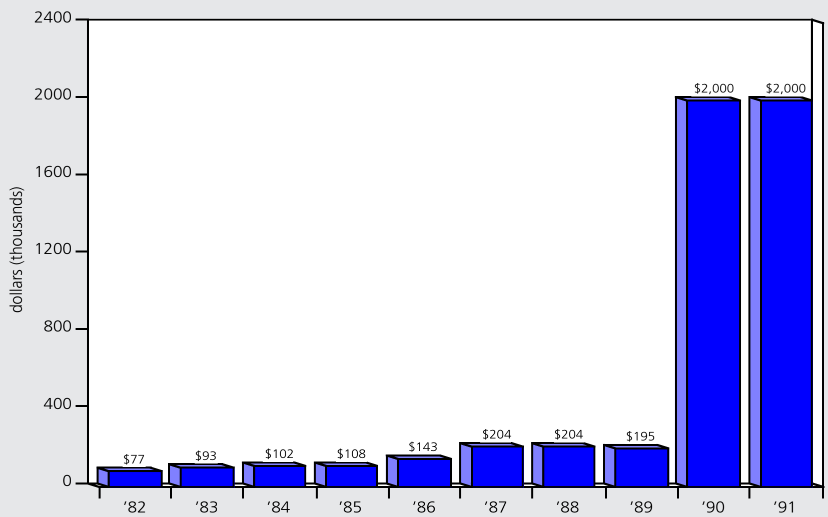
Highly contaminated qualify for federal Superfund listing and cleanup funds. Kentucky has 17 Superfund sites and two more have been proposed by the state. The cleanup of Kentucky's Superfund sites has progressed slowly.

Site	Status	Listed	Respon. Party
A.L. Taylor Valley of the Drums Brooks–Bullitt Co.	Cleanup complete. Operation and maintenance phase. (Responsible parties have established $800,000 trust for operation and maintenance.)	1981	Yes
B.F. Goodrich/Airco (2 sites) Calvert City–Marshall Co.	Cleanup alternatives challenged by state. Negotiations continue.	1982	Yes
Brantley Landfill Island–McLean Co.	Agreement signed 1990. Barmet Aluminum to conduct cleanup study.	1990	Yes
Caldwell Lace & Leather Auburn–Logan Co.	Responsible party refuses to cooperate. EPA will conduct cleanup study.	1990	No
Distler Brickyard West Point–Hardin Co.	Remedial design underway. Groundwater treatment system to be installed.	1982	No
Distler Farm Louisville–Jefferson Co.	Disposal of contaminated groundwater underway. Site will move into operation and maintenance.	1982	No
Fort Hartford Coal Olaton–Ohio Co.	Consent for removal has been signed. Barmet Aluminum has sealed site and will conduct cleanup study.	1990	Yes
General Tire & Rubber Mayfield–Graves Co.	Groundwater monitoring ongoing. Cleanup study underway.	1990	Yes
Green River Disposal Site Maceo–Daviess Co.	Consent for removal has been signed, 1990. Responsible parties to conduct cleanup study.	1990	Yes
Howe Valley Howe Valley–Hardin Co.	Cleanup alternative determined, to begin 1992.	1987	Yes
Lee's Lane Landfill Louisville–Jefferson Co.	Operation and maintenance phase. Negotiations underway with responsible parties and EPA.	1982	No
Maxey Flats Hillsboro–Fleming Co.	Cleanup alternative signed 1991. To take place over 35 to 100 years.	1986	Yes
Newport Dump Wilder–Campbell Co.	State will assume operation and maintenance.	1982	No
Red–Penn Sanitation Co. Peewee Valley–Oldham Co.	Draft work plan to initiate cleanup study has been released for public comment.	1989	No
Smith's Farm Brooks–Bullitt Co.	Cleanup plan prepared for one site. Study underway for other.	1984	No
Tri–City Indstrl. Disp. Site Books–Bullitt Co.	Remedial investigation ongoing. Superfund financed.	1989	No

Source: Kentucky Division of Waste Management; U.S. EPA, Region IV, 1991

The fee increases, which were implemented in 1990, were initially estimated to raise $5 million a year. However, the fund will fall short of this amount. The fees are generating approximately $2 million a year, due to the exemptions presently provided to some hazardous waste generators. (Another $1 million in fees are being legally challenged.) Some contend that the exemptions, such as those for hazardous wastewater, should be eliminated to ensure fairness to all generators and to help the fund accrue enough money for its intended uses. The fund may also be used to clean up hazardous waste sites that do not qualify for Superfund listing. DWM was unable to determine the amount of money spent from the fund to address non–Superfund waste sites, although it generally has not been used for this purpose.

Figure 19
State Hazardous Waste Management Fund Annual Fee Collection



Source: Kentucky Division of Waste Management, 1992

In 1981, a state fund was established to help finance the cleanup of hazardous waste sites. The fund is financed through fees on hazardous waste generators. In 1990, lawmakers increased the fees. However, the fund will still fall far short of what is needed to clean up waste sites in Kentucky.

536 Hazardous Waste Sites Identified in Kentucky Believed to be "Tip of the Iceberg;" Active Waste Site Discovery and Cleanup Initiative Needed

Laws requiring hazardous waste generators, transporters, and facilities to document that waste is transported and disposed through approved methods have helped prevent many illegal dumps. Unfortunately, waste dumps will continue to be created because of the costs of proper disposal and lack of concern or information regarding the hazards and liabilities associated with improper disposal. Pollution prevention requirements, rigorous enforcement, education, and technical assistance are necessary to ensure that both large and small quantities of hazardous waste are managed within the framework of environmental laws, and that future illegal waste sites are prevented.

The identification and cleanup of existing hazardous waste sites pose a significant challenge to the state. It is suspected that the 536 potential waste sites discovered to date, are just the "tip of the iceberg." With a more aggressive site discovery program, many more sites would likely be found.

Some states are using public service advertisements and toll–free hotlines to encourage citizens to report suspected sites. Thousands of hazardous waste sites have been discovered in Ohio through this citizen involvement approach, and Kentucky officials believe there would be a similar response here. (Louisville and Jefferson County recently established a hotline to report potential waste sites.)

However, the limited state resources available to conduct site investigations and cleanup activities are insufficient to fully address the sites already identified. It is vital that priorities be set for the remediation of those sites which pose the greatest threats to the environment and human health, and the status of these sites be adequately monitored by DWM. Identification, investigation, and a commitment of resources for the cleanup of hazardous waste sites is crucial if Kentucky is to minimize the public health and environmental risks posed by these sites.◆

Picture of drums full of hazardous waste

Municipal Solid Wastes

Kentucky first began regulating waste disposal in 1969. At that time, there were thousands of landfills and open dumps across the state, many unattended, which posed significant public health and environmental threats. In 1983, the state required new solid waste landfills (not existing ones) to install clay liners or demonstrate that the landfill could meet the clay liner requirements. Today, about half of the state's 76 residential landfills have clay liners. The remainder are "grandfathered" sites with no liners, or landfills that have clay liner equivalents.

In 1987, solid waste became a key public concern after the state was targeted for solid waste disposal by firms in the Northeastern U.S. where landfill capacity was virtually non–existent. With low waste disposal rates of $8 to $20 a ton, compared to $100 a ton in New Jersey and New York, Kentucky quickly became an attractive state for the disposal of long–haul garbage. This issue, combined with recent discoveries that many permitted landfills may be leaking contaminants into surface and groundwater, renewed state efforts to better site, construct, and operate solid waste landfills. In 1990, Kentucky enacted regulations to close substandard landfills. The standards were adopted to better plan and develop state–of–the–art facilities to meet disposal needs while protecting the environment. Additional solid waste laws were enacted in 1991 including a state goal to reduce the amount of solid waste going to landfills 25% by 1997.

Kentucky faces a number of challenges in managing its solid waste during the next decade and beyond. They include siting disposal facilities, providing residential garbage collection, reducing and recycling wastes, and cleaning up leaking landfills and open dumps. These issues, combined with the increasing rate at which waste is being generated, have moved solid waste into the forefront of Kentucky's, as well as the nation's, environmental priorities. This section reviews the status of municipal solid waste generation, disposal, and management in the Commonwealth.

Generation

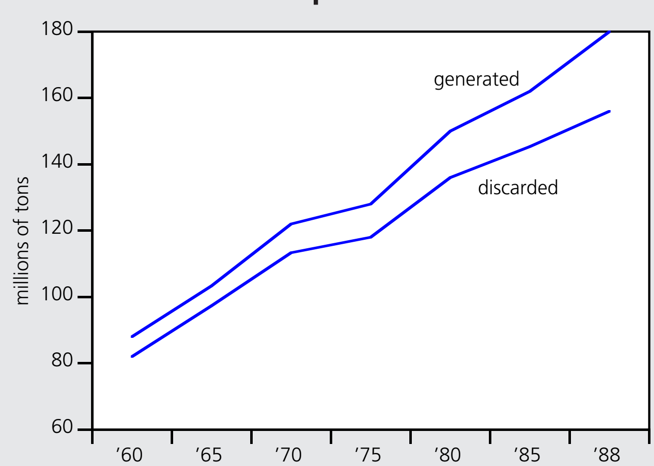
Municipal Solid Waste Generation in Kentucky Increasing; Estimated at 93 Million Tons During Next 20 Years

National trends show that between 1960 and 1988, the amount of garbage generated in the U.S. more than doubled **(Fig. 20)**. During 1960, a person typically produced 2.7 pounds of garbage a day. Today, that person generates about 4 pounds of garbage daily, an increase of 73% in just 30 years.

A 1990 study conducted by SCS Engineers for the National Solid Waste Management Association estimated that Kentucky generates 3.8 million tons of solid waste annually. This total includes residential, commercial, and industrial solid wastes disposed at municipal landfills. The Kentucky Division of Waste Management (DWM), however, estimates that the state generates 4.65 million tons of solid waste each year. Solid waste generation estimates prepared by counties and submitted to the Natural Resources and Environmental Protection Cabinet in October 1991, have verified the DWM estimate.

Figure 20

Total Solid Waste Generated in U.S. and Discarded in Municipal Waste Stream



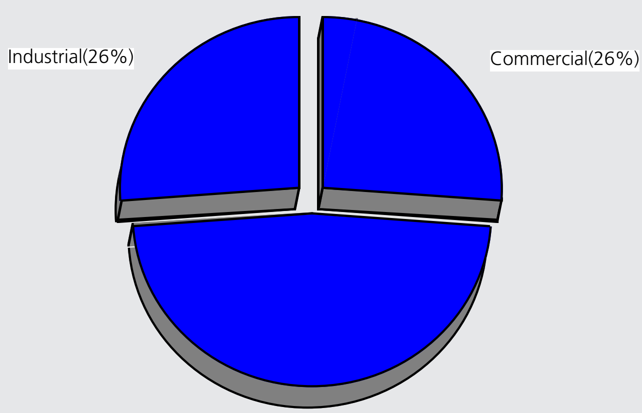
Source: Franklin Associates, Ltd., 1988

Between 1960 and 1988, the amount of waste generated and discarded in the U.S. more than doubled. Today, each person generates an estimated four pounds of garbage a day, an increase of 73% since 1960.

Some general observations can be made about wastes disposed at the 76 municipal solid waste landfills currently permitted to operate in Kentucky. Overall, residential household garbage and yard waste account for 48% of the solid waste disposed in municipal landfills **(Fig. 21)**. Commercial solid waste generated by small businesses such as restaurants, dry cleaners, and stores accounts for approximately 26% of the municipal waste stream. The remaining 26% of the waste disposed at municipal landfills is generated by industrial sources.

Comparing 1984 and 1990 generation estimates, the state's municipal waste stream increased approximately 7% to 10% during this six–year period. Waste generation is expected to increase 13% by the year 2000, based on projected economic and population growth. Kentuckians will generate 93 million tons of garbage during the next 20 years, according to county solid waste plans.

Figure 21
Municipal Solid Waste Generation in Kentucky by Source



Source: Kentucky Division of Waste Management. 1991; University of Kentucky Solid Waste Management Study, 1990; National Solid Waste Association, 1991.

An estimated 4.6 million tons of municipal solid waste are generated each year in Kentucky. Most of this waste stream is composed of household and yard waste.

Disposal

42 of State's 76 Municipal Landfills to Close or Convert to Another Use by July 1992; 23 Expected to Upgrade and Remain Open After 1995

The municipal solid waste stream is composed of seven major categories of waste—paper products, yard wastes, metals, plastics, glass, food wastes, and miscellaneous wastes including wood, textiles, leather, and inorganics. The generation of these wastes is expected to increase, with paper and paperboard leading in volume produced, according to national projections **(Fig. 22)**.

Kentucky's household garbage is currently disposed at 76 municipal landfills located in 64 counties. The state's only municipal waste incinerator, located in Louisville, closed in July 1991. Thirty–two of the municipal landfills are privately owned and accept the majority of wastes generated in Kentucky. Forty–three of the residential landfills are publicly owned, smaller in size, and handle a lower percentage of waste.

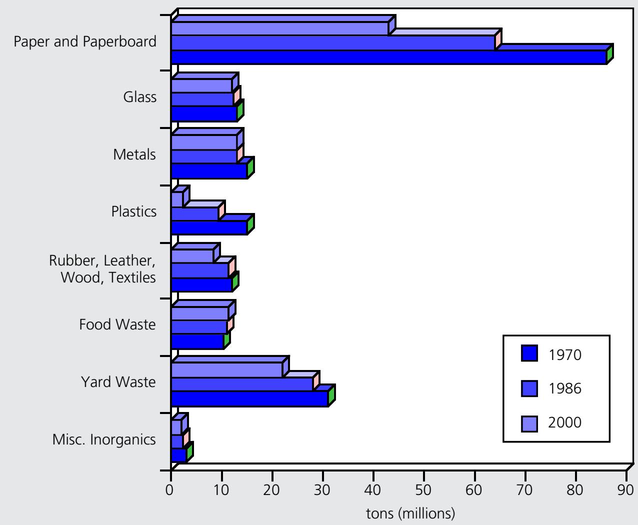
The number of municipal landfills has steadily declined since 1975 **(Fig. 23)**. By July 1, 1992, 35 of the state's 76 existing residential landfills will close, and seven will convert to construction/demolition debris or residual (industrial waste by–product) landfills. The closures are a result of the new state landfill design and operation requirements, pollution problems, or the landfill reaching its capacity. The remaining 22 private and 13 publicly–owned municipal landfills that have clay liners, leachate collection, and groundwater monitoring, or those with upgraded expansions, will be allowed to operate until 1995.

After 1995, all municipal solid waste landfills in Kentucky will be required to meet more stringent double liner or equivalent design and operation standards **(Fig. 24)**. Twenty–three of the 35 landfills remaining open until 1995 are expected to upgrade to meet the new standards and continue operating beyond 1995. The remainder will close or convert to another type of disposal facility. Twelve new municipal landfills have been proposed and, if permitted, would bring the total number of landfills open after 1995 to 35 **(Fig. 25)**.

The state needs approximately 4 to 5 million tons of capacity per year to adequately dispose of its solid wastes. Approximately 6.8 years of capacity will be available at the 35 landfills remaining open until 1995. Additional capacity will also be provided at existing municipal landfills that have applied for significant expansions to convert to contained (double liner) landfills, and new facilities, if approved by the state.

The combined capacity, should these proposed expansions and new landfills be found consistent with local solid waste plans and approved by the state, is more than 195 million tons, which is about 40 years of capacity. In 1991, solid waste permits were issued to a new municipal landfill in Pike County and a new construction/demolition debris landfill in Ohio County. Two major expansions at existing facilities were also approved for contained landfills in Ohio and Grant counties.

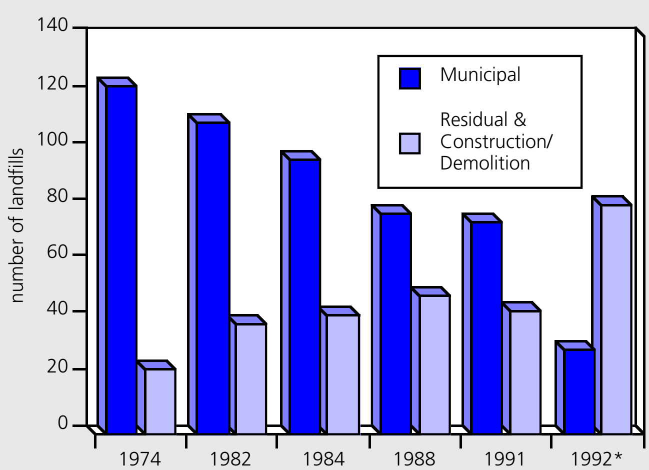
Figure 22
Current and Projected Municipal Solid Wastes Discarded in the U.S.



Source: Franklin Associates, Ltd., 1988

Paper and yard waste account for 58% of the municipal waste discarded. The generation of solid waste will continue to increase, according to national projections, with paper and paperboard waste leading in volume generated and discarded.

Figure 23
Municipal and Industrial Solid Waste Landfills in Kentucky



**projected*
Source: Kentucky Division of Waste Management, 1992

The number of municipal landfills in Kentucky has declined steadily since 1975 and now number 76. The number of permitted industrial solid waste landfills have, in comparison, increased.

Figure 24
Kentucky's 1990 Solid Waste Landfill Regulations

Background

The state solid waste landfill regulations enacted in 1990 set the standards for the development of new or expanding solid waste disposal facilities in Kentucky. The more significant portions of the regulations include:

- Hydrogeologic investigations;
- Location standards;
- Design and construction standards;

Location Standards

Kentucky has promulgated standards establishing criteria limiting landfill development to certain environmentally–acceptable areas. Buffer distances and/or siting exclusions are required for the following land features:

- Perennial or intermittent streams;
- Deep mine areas;
- Karst terrain;
- Property lines;
- Residential structures;
- Underground utility lines;

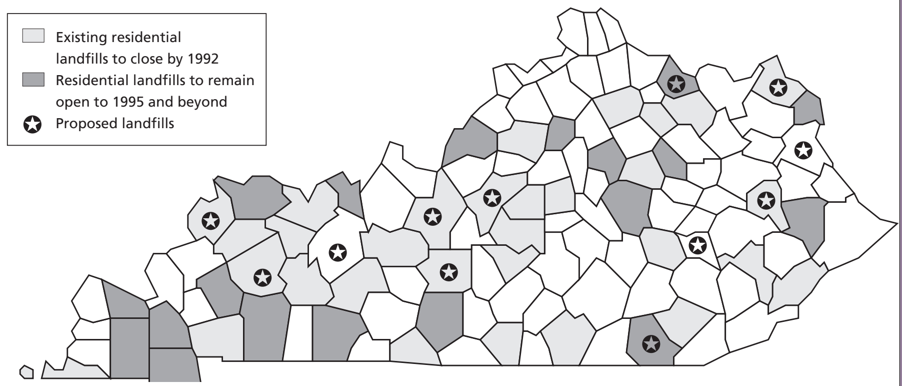
Additional requirements

Kentucky has also established more stringent requirements for landfill design and monitoring for both existing and new landfills. Critical among these requirements are those dealing with landfill liners, caps, leachate collection and groundwater systems.

- **Bottom Liner**—A bottom liner system is to be installed at all future landfills. This is known as a "double composite liner." Essentially, the equivalent of two separate clay layers and two separate flexible membrane (plastic) liners are to be installed. A leak detection system is to be installed between these liners to identify any leakage that may occur. Leachate collection will also be required.
- **Cap Systems**—A system of gas vents, clay, drainage, and vegetation zones are to be installed atop all completed landfills. This will ensure vegetation support while minimizing water infiltration into the landfill and inhibiting leachate generation.
- **Groundwater Monitoring**—Groundwater monitoring wells are to be installed around the landfill perimeter. These will be cluster wells with separate well points installed to different saturated zones. If a release of contaminants should occur from the landfill, contamination should be detected in the downgradient water monitoring wells. The requirement enumerates specific monitoring frequencies, parameters and analytical techniques. Statistical methods for interpreting data are also defined in the regulations.
- **Leachate Collection**—Leachate systems to collect water discharged from sites will be required atop the bottom liner of the landfill. All collected leachate is to be treated and properly disposed. This may include on–site treatment and discharge or pump/haul to local wastewater treatment plants.
- **Closure Care**—All landfills must be properly maintained and monitored for a 30–year period. The owner will have financial responsibility to ensure proper maintenance of the landfills.

Source: National Solid Waste Management Assoc., Kentucky Division of Waste Management, 1991

Figure 25
Status of Municipal Landfills in Kentucky



Source: Kentucky Division of Waste Management, 1992

By 1992, 42 of Kentucky's 76 municipal landfills will close or convert to another use as a result of new design standards, pollution problems, or the landfill meeting its capacity. Twenty-three landfills are expected to upgrade and remain open past 1995. Twelve proposed landfills are under review by the state.

Municipal Landfills in Kentucky to be Larger; Meet Stricter Construction and Monitoring Requirements

Landfills are expected to be the major disposal method for solid waste in Kentucky well into the future. The stricter state solid waste landfill regulations, however, will mean increased costs to construct and operate landfills. DWM estimates that construction costs to build a landfill under the new solid waste regulations will range from $150,000 to $300,000 per acre. In view of these costs, experts believe that in order to be economically feasible, the size of an average landfill in Kentucky will increase and handle much greater quantities of waste daily.

The new standards will also mean higher disposal costs. The state estimates that average household garbage disposal bills will increase from the current rate of $4 to $6 a month, to $9 to $12 a month. Tipping fees at landfills are expected to increase from $6 to $20 per ton, to approximately $28 to $33 per ton, the current national average.

The state is encouraging counties to band together and site regional landfills in order to minimize garbage disposal costs to individual households. All counties were required to notify DWM by June 1991 whether they will manage their waste as a single county, or participate in a regional pact for the disposal of wastes. Two regions—Bracken, Fleming, Lewis, Mason, Robertson, and Nicholas counties; and Boone, Kenton, and Campbell counties—have indicated that they will use a regional solid waste disposal approach. As counties develop solid waste plans, it is believed that more multi–county waste disposal initiatives will be forthcoming. Also, many counties are informally working together to dispose solid waste. Currently, 68 (56%) of the state's 120 counties are designating multiple disposal sites to ensure that current and future capacity needs are met.

With fewer landfills and less competition, concern has been expressed that household disposal rates and tipping fees will increase dramatically in Kentucky. Counties will be required to report disposal rates and tipping fees annually to the state, beginning in 1993. This will allow the state to monitor trends and assess the need for rate controls.

Alternative Disposal Technologies Play Limited Role in Kentucky

National projections indicate that landfills will continue to be the primary disposal method for municipal wastes, with waste–to–energy facilities growing steadily **(Fig. 26)**. Waste–to–energy facilities, which require large quantities of waste to operate economically, have been slow to develop in Kentucky and may not represent any significant portion of the state's waste disposal in the future.

One of the few alternative solid waste disposal technologies considered in Kentucky was the development of a refuse-derived fuel facility (RDF) in Louisville. The City of Louisville engaged in contract negotiations with Louisville Energy and Environment Corporation (LEECO) to create a materials recovery facility and a combustion unit for refuse-derived fuel. This facility would be designed to process up to 210,000 tons/year of solid waste, providing sufficient capacity to process Louisville's residential waste stream.

In the proposal, approximately 60% of the city's waste would be converted to RDF and incinerated in a fluidized bed combustion unit constructed at the abandoned Louisville Gas and Electric power plant. The resulting steam would be sold to the adjacent DuPont plant. The remaining 40% of the waste would be recovered as recyclables, composted, or landfilled. Capital expenditures for this venture would be provided by LEECO, in exchange for an exclusive long–term contract with the city. The contract, which was submitted to the city in September 1991, was withdrawn in March 1992. Members of the Board of Aldermen and evironmentalists were critical of the proposal and instead emphasized recycling and composting as waste management options. The city will continue to dispose its waste at the Outer Loop Landfill in Jefferson County for the foreseeable future.

Figure 26
How the Nation's Waste is Managed

	1980		1986		1988		1995		2000	
	tons*	**%**	**tons***	**%**	**tons***	**%**	**tons***	**%**	**tons***	**%**
Recycling	14.5	10	18.3	11	23.5	13	48.3	24	54.4	25
Waste-to-Energy	2.7	2	9.6	6	24.5	14	45.0	23	55.0	26
Incineration[1]	11.0	7	3.0	2	1.0	2	0.5	0.3	0.1	<0.1
Landfill	121.4	81	136.5	82	130.5	73	106.0	53	106.5	49

** in millions of tons per year*

[1] Incineration without energy recovery

Source: Franklin Associates, Ltd., 1990

National projections indicate that landfills will continue to be the primary disposal method for municipal solid wastes, with waste–to–energy facilities and recycling increasing steadily.

20% of Municipal Waste Disposed in 1990 was Out–of–State Garbage; Amount Has Since Declined

The disposal of out–of–state garbage in Kentucky has been one of the most emotionally–charged environmental issues in recent years. With the closing of some 14,000 landfills across the nation during the past decade, and with one–third of those remaining scheduled to shut down within five years, many states are struggling with how to dispose of their wastes. In 1987, waste brokers began diverting some solid waste from New Jersey, New York, and Pennsylvania to Kentucky landfills. Developers also turned to the state as a location for "mega–landfills" to accept solid wastes from out–of–state sources.

To stem the flow of out–of–state garbage entering the state, in 1988 the state required any municipal solid waste landfill accepting wastes from outside Kentucky to have in place a soil liner, leachate collection, and groundwater monitoring, or demonstrate that the waste does not contain hazardous wastes from limited quantity generators. Limited quantity generators produce less than 220 pounds of hazardous wastes per month, and typically include dry cleaners, gas stations, printers, and hospitals.

Figure 27

Out–of–State Solid Waste Shipments into Kentucky (tons)

Facility	County	Source	1st Qtr. 90	2nd Qtr. 90	3rd Qtr. 90	4th Qtr. 90	1st Qtr. 91
Bavarian Trucking Company	Boone	Hamilton, OH	2,686	2,735	2,859	2,142	2.073
		Switzerland, IN	412	500	504	264	456
Cooksey Bros. Disposal Company	Boyd	Wayne, WV	1,695	1,953	300	601	[2]1,496
		Cabell, WV	778	1,049	491	354	1,804
		Lawrence, OH	3,422	5,362	5,511	5,191	5,154
		Pennsylvania	0	6,942	9,499	0	0
Raymond Carpenter	Fleming	Philadelphia, PA	14,445	19,398	[1]	28,550	[2]6,475
		Columbia, PA		0	0	0	436
		N. Hampton, PA		0		0	2,155
		Lehigh, PA		0		303	0
		Delaware, PA		0		1,561	0
		Montgomery, PA		0		23	0
Hilltop Landfill/ Greenup Sanitation Service	Greenup	Scioto, OH	1,624	2,447	3,603	834	[2]
Roe Creek Development Inc.	Lawrence	Source Unspecified				9,562	7,142*
		Ohio	7,169	7,974	8,293		
		New York	570	3,768	8,788		
		New Jersey	709	1,000	1,160		
		Pennsylvania	354	1,148	2,040		
		W. Virginia	264	332	540		
		Massachusetts	288	1,115	1,284		
		Connecticut	723	697	860		
		Rhode Island	68	193	276		
		Missouri	14	0	0		
		Virginia	66	383	943		
		Washington, DC	181	228	231		
		Maryland	63	650	502		
		Vermont	0	19	58		
		New Hampshire	0	15	184		
Valley View Landfill, Inc.	Trimble	Indiana	42,858	0	0	0	45,605
		Ohio	229	96	131	130	0
		Campbell, TN	0	31	0	0	0
		Bergen, NJ	121,591	159,164	96,182	122,732	27,964
Dozit Co.	Union	Saline, IL	554	564	34	0	0
		Gallatin, IL	6	30	81	560	790
		Mossac, IL	0	0	0	222	0
Tri–County Sanitary Landfill, Inc.	Whitley	Campbell, TN	432	376	357	318	[2]650
Pulaski Landfill Inc.	Pulaski	Source Unspecified	3,809	4,388	5387	5,721	
		Florida					64*
		North Carolina					147*
		Alabama					108*
		Indiana					41*
		Maryland					244*
		Ohio					746*
		South Carolina					150*
		Tennessee					504*
		Virginia					2,160*/15**
		New Jersey					24*
		Pennsylvania					2*
		West Virginia					5*
Totals			205,010	222,557	150,098	179,068	109,377

[1] *No quarterly report on file.*
[2] *No 1st quarter report for 1991 in file. Data from 2nd quarter report 1991.*
* *Asbestos*
** *Contaminated soil*

Source: Kentucky Division of Waste Management, Quarterly Reports, 1990-1991

The disposal of out–of–state garbage in Kentucky has been one of the most publicly–charged environmental issues in recent years. During 1990, 757,000 tons of waste were shipped to Kentucky from 12 states. Quarterly waste reports show a steady decrease in the total amount of out–of–state garbage disposed at landfills in Kentucky.

These requirements limited the disposal of out–of–state garbage to nine Kentucky landfills. During 1990, these landfills reported receiving about 757,000 tons of garbage from out–of–state. During the first quarter of 1991, Kentucky received wastes from 12 states: Ohio, Indiana, Illinois, Tennessee, West Virginia, Pennsylvania, South Carolina, North Carolina, Alabama, Virginia, Maryland, and New Jersey.

The disposal of out–of–state solid wastes in Kentucky has decreased, based on quarterly reports filed by landfill operators **(Fig. 27)**. This is primarily due to the reduction of New Jersey wastes sent to the Valley View Landfill in Trimble County. The landfill received 122,000 tons of New Jersey garbage during the last quarter of 1990. In comparison, only 27,000 tons of New Jersey waste were received at Valley View during the first quarter of 1991. In November 1991, a Fleming County landfill accepting out–of–state garbage from Pennsylvania was closed after reaching its permitted capacity.

The state enacted regulations in 1990, and legislation in 1991, limiting increases in shipments received at existing landfills to 5% of the wastes currently permitted for disposal. These limitations, effective until July 1, 1992, were passed in order to preserve disposal capacity for Kentucky–generated solid wastes. They were also intended to discourage the 35 landfills slated to close in 1992 from filling up their remaining substandard space with out–of–state garbage.

1,240 Limited Quantity Hazardous Waste Generators Registered; One Solid Waste Landfill Permitted to Dispose This Waste

Municipal landfills in Kentucky also receive a variety of wastes that contain toxic constituents produced by households, businesses, site cleanups, and sewage treatment plants. Hazardous wastes produced by limited quantity generators—those businesses that generate less than 220 pounds of hazardous waste a month—may be disposed in permitted hazardous waste facilities or at state–approved solid waste landfills. As of October 1991, 1,240 limited quantity hazardous waste generators had voluntarily registered in Kentucky. Since there is no regulatory requirement to register, this estimate may not be an accurate representation of the number of limited quantity generators in the state.

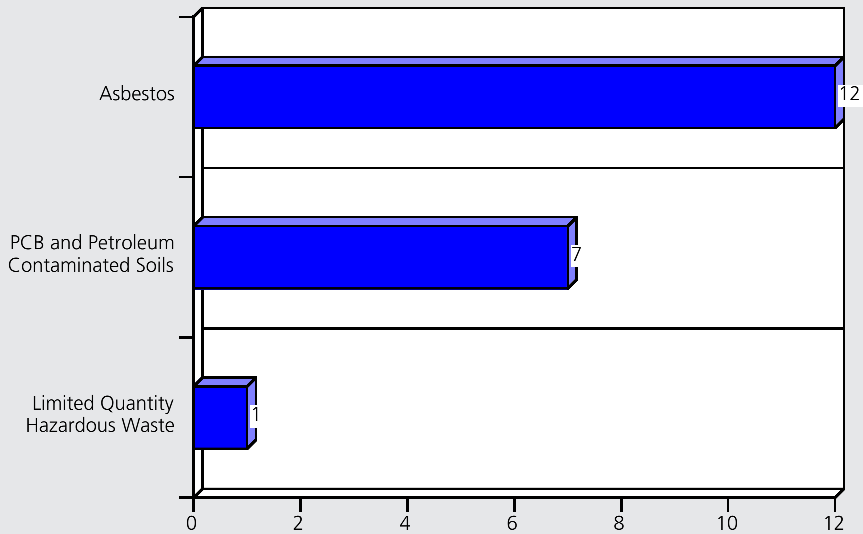
DWM increased inspections of limited quantity generators from 96 in 1990, to 157 in 1991. Even more inspections are scheduled to be conducted in 1992 to determine how this waste is disposed. It is believed that most limited quantity generators contract to have their waste treated or disposed at hazardous waste facilities. Only one solid waste landfill in the state, LWD Sanitary Landfill in Marshall County, is currently permitted to accept limited quantity hazardous waste.

Solid Wastes With Toxic Constituents Disposed at 18 Municipal Landfills

Some municipal landfills are also permitted to receive other wastes containing toxic constituents. Petroleum and PCB–contaminated soils, as well as asbestos, are allowed to be disposed in state–approved solid waste landfills that have clay liners. Groundwater monitoring and leachate collection systems are required at these facilities to prevent environmental contamination. As of December 1991, 12 landfills were permitted to accept asbestos wastes and seven were permitted to accept petroleum and PCB–contaminated soils **(Fig. 28)**. Landfills permitted to receive these wastes all have clay liners and monitor groundwater for contamination. Only three of the landfills monitor groundwater for the presence of toxic organics.

Petroleum–contaminated soils are primarily generated from cleanups of leaking underground storage tanks. Approximately 34,000 underground storage tanks are registered with the state, most of which are located at gas stations. The U.S. EPA has estimated as many as 25% of the nation's underground storage tanks may be leaking petroleum into soils. State regulations, adopted in 1988, required many old tanks to be replaced, and the contaminated soils excavated and disposed in properly permitted landfills. As of December 1991, 1,175 tanks have been replaced or closed in Kentucky.

Figure 28
Municipal Waste Landfills in Kentucky Permitted to Accept Wastes with Toxic Constituents



Asbestos
Southern Sanitation, Logan Co.
Tri–K, Lincoln Co.
Waste Management, Jefferson Co.
Pulaski Landfill
Valley View, Trimble Co.
Tri–County, Whitley Co.
Bavarian, Boone Co.
Cooksey, Boyd Co.
Herman Crouch, Estill Co.
Lexington/Fayette Co. Landfill
BFI, Franklin Co.
E.R. Hopper, Laurel Co.

PCB or Petroleum Contaminated Soils
Bavarian, Boone Co.
Lexington/Fayette Co. Landfill
BFI, Franklin Co.
Waste Management, Jefferson Co.
Southern Sanitation, Logan Co.
Pulaski Landfill
Valley View, Trimble Co.

Limited Quantity Hazardous Waste
LWD Sanitary Facility, Marshall Co.

Source: Kentucky Division of Waste Management, 1991

Some municipal solid waste landfills are permitted to accept wastes with toxic constituents. Landfills that receive these wastes have clay liners and must monitor groundwater.

Soil cleanups have taken place at 75% of these sites. Disposal needs for petroleum–contaminated soils are expected to increase as more tanks are replaced. DWM reports that an average of 25 facilities a month are replacing or closing tanks in place.

A facility using a new process to treat petroleum–contaminated soils is under construction in the city of Franklin in Simpson County. The Triple M Company has proposed a biotreatment system for contaminated soils. The facility has received a Research and Development construction permit from DWM and a water discharge permit from the Division of Water. The process uses naturally occurring organisms to treat the contaminated soil. Another facility had been proposed in Pikeville for cleansing soil contaminated by petroleum from leaking underground storage tanks. This plant intended to heat 240,000 tons of petroleum contaminated soil each year until the gasoline and diesel fuel vaporized. Public opposition to this new technology and technical deficiencies led the state to reconsider issuance of an air quality permit. The company recently decided to drop its plan to construct the plant. The state has also suspended permits for two mobile soil cleaning plants for further review.

Under current federal regulations, soils containing polychlorinated biphenyls (PCBs) of less than 50 parts per million, can also be disposed in solid waste landfills. PCBs, used as coolants in electrical transformers, were banned from production in 1978 after they were discovered to cause skin rashes and were suspected of causing cancer. A substantial portion of the PCBs produced still remain in transformers and other electrical equipment. A state effort to identify and require the cleanup of PCB–contaminated soils began in 1987. Since then, contamination has been discovered at 24 of the state's 61 natural gas pipeline transmission stations in Kentucky where PCBs were once used as lubricants. Cleanup plans are under development at these and other sites. These contaminated soils ultimately may be disposed at solid or hazardous waste landfills, depending on the level of contamination and the outcome of the current state debate on cleanup standards.

Asbestos, an insulating material once widely used in buildings and considered dangerous if inhaled, has been banned from use in construction materials. State and federal efforts have focused on the removal of asbestos from schools and other public and private buildings. Asbestos is considered an acceptable waste stream for solid waste landfilling, provided it is handled in a manner to prevent breakage of bags and the airborne release of this material. One landfill accepting asbestos, primarily from out–of–state, had its permit modification revoked in 1991 due to poor asbestos waste handling practices.

Some Efforts Made to Divert Household Hazardous Wastes, Agricultural Pesticide Containers, and Used Oil from Landfills

Other hazardous or toxic wastes commonly disposed in municipal solid waste landfills include household hazardous wastes, car batteries, and empty agricultural and commercial pesticide containers. While household hazardous wastes are estimated to make up only 1% of the municipal solid waste stream, the potential for these wastes to contaminate soil and water is great. This threat led the state to adopt the double liner construction standards for solid waste landfills in 1990.

Efforts to ban or divert some of these hazardous materials from landfills have been initiated. For example, state legislation banned the disposal of lead acid batteries in solid waste landfills after January 1991. State, local, and private programs to divert used oil from landfills are ongoing. An estimated 19 million gallons of used automotive and industrial oil require disposal each year in Kentucky. Because it only takes one quart of used oil to contaminate a million gallons of water, programs to collect and recycle used oil are being promoted. It is not known how many gallons of used oil have been collected and recycled in Kentucky. Most full–service gas stations recycle their used oil and some accept used oil from individuals. In Lexington, 30 collection stations accepted 21,000 gallons of used oil in 1990. A coordinated state/industry program was recently announced to collect used oil at 141 locations in 48 Kentucky counties.

Attention has also been focused on promoting alternative disposal methods for unused agricultural pesticides and containers. Empty commercial agricultural chemical containers can be disposed in solid waste landfills. Most facilities, however, do not accept these wastes due to liability concerns. It is not known how many agricultural chemical containers have been sold in Kentucky and need disposal since there are no inventory records available.

Some state and local efforts to collect unused over–the–counter pesticides, paint, and other household toxic materials and dispose them at hazardous waste facilities have been initiated. Louisville, in cooperation with the Metropolitan Sewer District, held a household hazardous waste collection day in 1990, and is researching methods to finance a permanent program. Atochem of Carrollton has sponsored local household hazardous waste collection days in 1990 and 1991. Toyota is sponsoring a collection day in Scott County in the near future.

The Kentucky Division of Pesticides and the Department for Environmental Protection recently sponsored a pilot project in Marshall and Caldwell counties to collect unused agricultural chemicals through a Farm Chemical Amnesty Collection program. Nearly 5,300 gallons of chemicals were collected. The program was considered so successful that it may be initiated statewide. However, one–day collection projects are expensive and not always convenient to the general public. Some communities are holding workshops on household hazardous wastes and are considering establishing permanent centers to collect paint, used oil, and other household toxic materials for reuse or disposal.

Local Solid Waste Management

All Counties Submit Updated Solid Waste Plans on Capacity Needs; 119 Approved

In 1982, Kentucky law declared that the primary responsibility for municipal solid waste collection, management, treatment, disposal, and resource conservation rests with counties. At that time, each county was required to develop a 20–year solid waste management plan. By 1987, all 120 counties had state–approved solid waste management plans. County fiscal courts or solid waste districts have the responsibility of implementing the plans. Eleven counties (Bath, Bell, Jackson, Johnson, Harlan, McCreary, Marshall, Montgomery, Pulaski, Shelby, and Trimble) established solid waste districts to implement their plans and manage all aspects of solid wastes within their designated geographical area.

Success in implementing county solid waste plans varies from county–to–county. The plans have been effective in educating local officials and the public regarding solid waste issues and needs. Many plans, however, have not been fully implemented due to local turnover of county government administrations and the inability of the state to require local action. New laws passed in 1991 should assist in the development and implementation of more effective plans. Greater public participation in the planning process will also assist in providing the support necessary to carry out the solid waste plans.

Local solid waste plans must now be updated. Counties were required to submit the first phase of their plans by October 1991. This first phase outlines solid waste generation rates and disposal capacity needs. The second phase of the county solid waste plans is due by January 1993, outlining a comprehensive approach to collecting, disposing, and reducing solid wastes.

If a county does not develop a local plan, the state may develop one for the county. Also, if a county does not implement its plan, the state cannot approve any local requests for state or federal financial assistance for various economic development projects which generate solid waste. Ninety–two counties have requested and received state grant monies to assist in updating solid waste plans. All counties have submitted phase one of their plans and currently 119 have been approved. Only one county has not developed an acceptable plan, according to state officials. The state has indicated that it will not approve state or federal funds for various projects in Magoffin County until an appropriate solid waste plan is submitted. Magoffin County has been embroiled in the siting of a controversial municipal solid waste privately-owned landfill, proposed to be the largest in the state.

State funds are also available to assist counties with solid waste management. The state Solid Waste Revolving Loan Fund and Grant Program was established in 1991. Of the $16 million appropriated to the loan program, $1.6 million has been awarded to 63 applicants during 1991. An estimated $3.75 million in grants have been awarded for projects in 71 counties and ten cities. These grants will fund various solid waste projects including equipment to clean up open dumps and collect garbage.

County Governments Given Authority to Determine Future Amount of Out–of–Area Garbage Entering Their Communities

Options to ban out–of–state garbage from landfills were reviewed during a special session of the state Legislature in 1991. A major obstacle to controlling the importation of solid waste is the Commerce Clause of the U.S. Constitution. This clause essentially provides that a state may not restrict the flow of interstate commerce, including garbage. Several bills have been considered in Congress to allow states to ban out–of–state garbage or charge differential fees for wastes entering a state. The debate is expected to continue during the reauthorization of the federal Resource Conservation and Recovery Act in 1992 - the national law governing solid and hazardous waste management.

In the meantime, county governments have been given the authority, under state legislation passed in 1991, to determine the future amount of out–of–area garbage coming into their communities. Through the development of 20–year county solid waste plans, local governments will have the ability to review and determine the capacity of new or upgraded landfills to accept out–of–area wastes. Under the state's 1991 solid waste law, DWM can only permit new and increased capacity at landfills consistent with the disposal needs identified in county or multi–county plans.

Of the 119 county solid waste plans approved, 105 designate fiscal courts to determine whether a new or expanding landfill is consistent with the plan. The remainder have designated solid waste boards or 109 Districts as their governing body. Whether this "local determination" provision will effectively and legally allow counties to limit the disposal of long–haul wastes and preserve the state's landfill capacity remains to be seen.

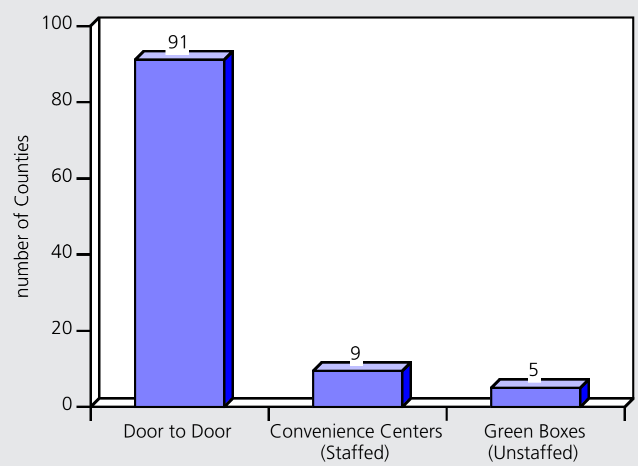
New State Requirements Result in 105 County Garbage Collection Ordinances

It is estimated that 10% to 20% of the solid waste generated in Kentucky is illegally disposed. In an effort to curb dumping, counties are now required to provide a voluntary municipal solid waste collection program to all residents by July 1, 1994. If a county does not establish a collection program, it will risk losing state or federal economic development funds.

As of January 1992, 105 counties had adopted universal collection ordinances **(Fig. 29)**. These ordinances will provide the public with access to garbage disposal through either door–to–door collection, staffed convenience centers, or collection boxes. Prior to February 1991, only 14 counties had universal collection ordinances for the countywide collection of solid wastes.

Figure 29
County Garbage Collection in Kentucky

based on 105 counties with universal collection



Source: Kentucky Division of Waste Management, 1992

Counties are required to establish ordinances to provide residential garbage collection by 1994. It is hoped these ordinances will assist in discouraging illegal dumping which is how 10- 20% of the waste generated in Kentucky is disposed.

Two Counties Hire Local Landfill Inspectors; 40 Establish Solid Waste Coordinator Positions

In 1980, counties were given the authority to assess a license fee of up to 50 cents for each ton of waste placed in landfill, or 5% of the gross receipts. The fee could be used to set up local landfill inspection programs to supplement state inspections. Currently, four counties (Estill, Pulaski, Fleming, and Trimble) have established ordinances to collect fees on garbage received at landfills. Trimble and Pulaski counties are using those fees to employ an enforcement officer to monitor landfill operations. Trimble County received $687,000 in 1989 from its 6.25% fee on the $11 million in revenue generated from Valley View Landfill. At that time, the landfill was receiving 2,000 to 2,500 tons of waste a day and charging a tipping fee of $20 per ton.

Most Kentucky counties have not taken the initiative to establish disposal fees and hire local inspectors. Some have chosen instead to create solid waste coordinator positions to monitor solid waste problems and complaints. To date, 40 counties have solid waste coordinators, a significant increase from ten in 1990.

To ensure proper handling and disposal of wastes, full–time state inspectors or equivalents are specified to be in place at all landfills by July 1992. The Kentucky Department for Environmental Protection has proposed to install surveillance cameras at landfills and hire six security officers to monitor operations to meet this requirement. However, due to funding shortfalls, the Cabinet has indicated that these measures will not be implemented until 1994.

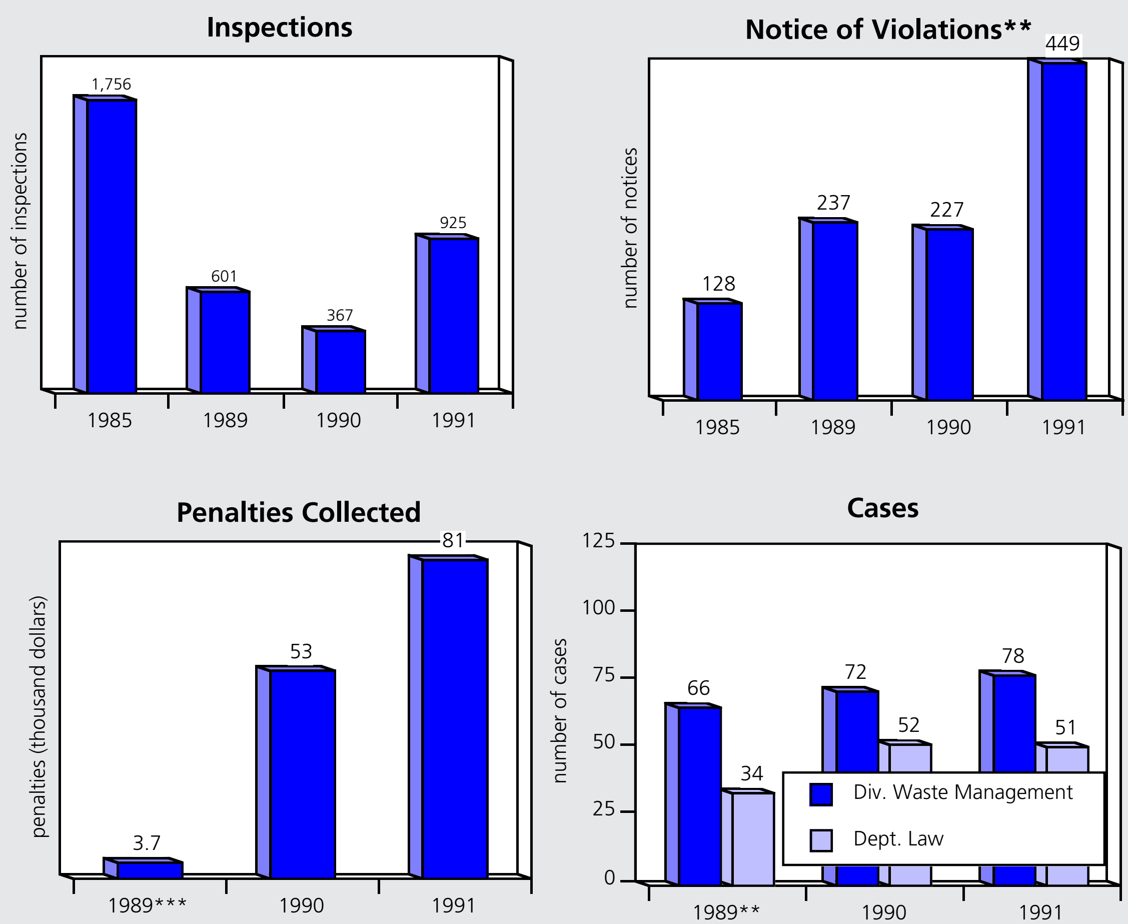
Enforcement

State Cites More Solid Waste Violations

In 1990, DWM conducted 367 inspections at permitted solid waste disposal sites **(Fig. 30)**. These included residential landfills, inert commercial and industrial landfills, and landfarming operations. Although this number is significantly less than the 1,756 inspections conducted in 1985, DWM notes that enforcing additional regulatory standards require more thorough, in–depth inspections, including the review of records landfills are now required to maintain. In 1991, state inspections increased to 925 and Notices of Violations nearly doubled after Senate Bill 2 was enacted and solid waste became a state priority. The agency also added additional inspectors to monitor solid waste operations.

High staff turnover has affected the state's solid waste enforcement program. In 1991, 80% of the 30 solid waste inspectors had less than one year's experience.

Figure 30
State Solid Waste Enforcement Activities*



**A Notice of Violation may include several violations of environmental regulations*

***Earlier data not available*

Source: Kentucky Division of Waste Management, 1992

The most common solid waste violations detected by DWM inspectors include:

- Disposal of solid waste at an unpermitted facility;
- Failure to apply daily cover;
- Failure to control litter;
- Failure to control leachate outbreaks;
- Failure to comply with permit conditions; and
- Failure to comply with environmental performance standards.

There has been an increased emphasis by DWM to address unpermitted disposal sites and respond to citizen complaints. In 1990, DWM responded to 608 citizen complaints, compared to 567 in 1985. DWM investigations resulted in 227 formal notices of violation in 1990, compared to 128 in 1985.

High staff turnover has affected the DWM enforcement program. In 1985, most of the Division's inspectors had two or more year's experience. In 1990, approximately 80% of the 30 full and part–time solid waste inspectors had less than one year's experience.

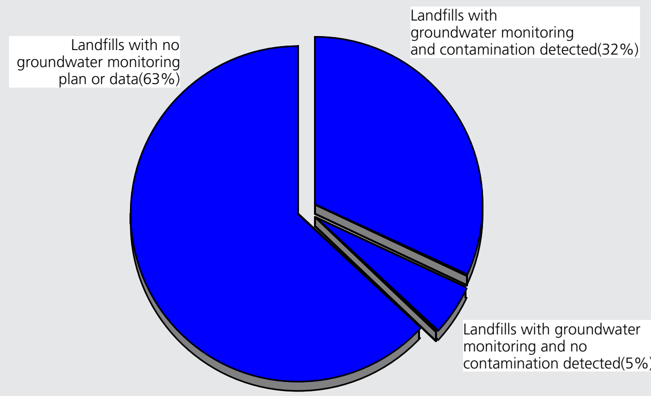
To promote compliance at solid waste disposal facilities the state enacted a law, effective February 1991, that requires background checks on key personnel of any waste company or operation. This will enable the state to permit a facility based on an applicant's history of compliance with environmental laws. DWM has developed disclosure forms and has conducted four background checks to date—three at existing landfills seeking expansion, renewal, or transfer of ownership, and one at a proposed new landfill. The Division did not uncover any problems as a result of the four checks. Eighteen additional background checks are pending review.

Contamination Detected at 26 of the 32 Municipal Landfills Monitoring Groundwater

Contamination has been detected at 26 of the 32 municipal solid waste landfills that currently monitor groundwater **(Fig. 31)**. Information about groundwater impacts at the other 44 existing landfills will be available through closure monitoring data and a state requirement that all landfills have groundwater monitoring in place by July 1992.

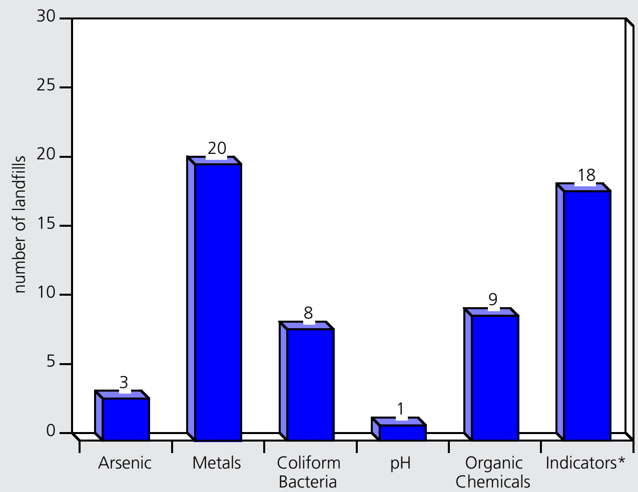
Figure 31

Status of Groundwater Monitoring at Municipal Solid Waste Landfills in Kentucky



Note: Based on 76 municipal landfills operating in Kentucky.

Type of Contamination Detected at Municipal Landfills with Groundwater Monitoring



**Includes pH, iron, sodium, total organic carbon, total dissolved solids, total organic halides.*
Source: Kentucky Division of Waste Management, 1991

It is suspected that many municipal solid waste landfills may be leaking contaminants into the groundwater. Mandatory groundwater monitoring, which takes effect in July 1992, will assist in determining the extent of contamination at municipal solid waste landfills in Kentucky.

It is suspected that most of the state's existing landfills are leaking contaminants into the groundwater. The closure and monitoring of substandard landfills will assist in determining the extent to which these landfills are contaminating the groundwater. Fourteen landfills are also monitoring for organic chemicals and thirteen have detected these chemicals in the groundwater.

Transportation

Shipping Manifests Will Help Track Solid Waste Disposal at Landfills; 28 Transfer Stations in 22 Counties Registered with State

In the near future, all wastes received at municipal solid waste landfills, transfer stations, and other municipal solid waste disposal facilities must be accompanied by a written manifest identifying its composition, where it originated, and who handled it. This requirement is expected to take effect in 1992 upon the adoption of regulations. The Kentucky Department for Environmental Protection is currently reviewing the use of computerized electronic manifests. Such a system could assist the state to more efficiently process and monitor information on waste shipments. Waste haulers must also be licensed by the Kentucky Transportation Cabinet beginning in 1992.

Because of the state's rural nature and the requirement that counties have collection systems in place by 1994, it is expected that the number of convenience centers to collect wastes, and the number of transfer stations where wastes are processed for transportation, will increase. The use of transfer stations in Kentucky to "disguise" the content of baled solid wastes and their point of origin has been a state concern. Under the state solid waste regulations, adopted in 1990, transfer stations are required to register with the Division of Waste Management to better monitor these operations. To date, 28 transfer stations located in 22 counties have registered with the Division.

Waste Reduction and Recycling

State Sets 25% Solid Waste Reduction Goal; Seven Facilities Compost Yard or Food Waste

In 1991, the state adopted a goal to reduce the weight of wastes received at municipal solid waste landfills 25% by 1997. There is no historical data available to document the amount of material diverted from the waste stream by recycling in Kentucky. The U.S. EPA estimates that recycling activities, on average, have reduced residential wastes three to ten percent. Beginning in 1992, recyclers will have to register and file annual reports with the state on the weight of municipal solid waste they recycle. Counties will report on recycling activities as well.

In general, consumers have had little incentive to limit their waste generation, because they are not charged for disposal based on the amount of waste they produce. Public opinion has changed significantly during the past few years, and awareness of the need to reduce and recycle wastes is growing. According to the aluminum industry, an estimated 55 billion of the 86 billion aluminum beverage cans produced nationally were recycled in 1991. This amounts to the recycling of two out of three aluminum cans. There have been a number of successful recycling initiatives undertaken throughout the state **(Fig. 32)**.

A 1990-91 survey of Kentucky cities and counties conducted by the Environmental Quality Commission identified 16 communities with curbside collection or pilot curbside programs for recyclables. The survey also revealed that rural communities are turning to centralized centers to collect recyclables. Pike County opened six drop–off recycling centers at various locations within the county. Meade County established a drop–off center staffed by volunteers. Rowan County is involved in the formation of a city/county nonprofit recycling center. Several county courthouses and city halls have started white paper recycling programs.

Figure 32
Local Government Recycling Efforts in Kentucky

ADD*/County/City	Status of Efforts
Barren River ADD	
Barren Co.	Researched markets.
Warren Co.	Public education program. Monthly drop off point.
Lake Cumberland ADD	
McCreary Co.	Recycling at 3 county convenience centers.
Ky. River ADD	
Leslie Co./Lewisburg	Haulers are recycling.
Owsley Co.	Haulers are recycling.
Perry Co./Vico	Special bags given to residents for curbside recycling of aluminum cans. Money donated to volunteer fire department.
Pennyrile ADD	
Christian Co./ Hopkinsville	Pride, Inc. a city agency, is conducting a "Partners Against Litter" recycling program. City is researching recycling programs and grant monies.
Trigg Co.	Metal separated at landfill.
Purchase ADD	
ADD District	Proposed W. Ky. Easter Seal Recycling Center. Will recycle paper for 8-county area.
Calvert City	Local committee to study waste stream reduction through household separation. Curbside program to begin next fiscal year.
Paducah	City constructing a composting facility for yard waste.
Northern Ky. ADD	
ADD District	Survey of recycling programs. Regional recycling program under study.
Boone Co.	3,000 homes participating in a pilot curbside recycling project.
Walton	County is studying the need for a recycling and composting center. Drop off site at park. Monthly collection.
Campbell Co.	County offices participate in white paper recycling. Fiscal court placed recycling bin at middle school. Other cities in county are adopting curbside recycling programs.
Cold Spring	Working on bin and curbside program. Studying city compost program.

ADD/County/City	Status of Efforts
Bellevue	Allotted $5,000 for public education. Formed citizens committee. City has contracted with private hauler for a recycling bin.
Kenton Co.	Several cities in Kenton Co. have started pilot curbside and bin collection programs.
Ft. Wright	June, 1990 began curbside for plastics, glass and aluminum. Paper will be included in 1991/92 contract.
Ft. Mitchell	Contractor to collect twice/month at curbside.
Elsmere	Curbside pickup one a month.
Erlanger	Curbside collection of leaves and composting.
Crestview Hills	Recycling education committee. Drop bins for newspaper, aluminum, plastic. Bids sent out for curbside collection.
Lincoln Trail ADD	
Hardin Co./ Elizabethtown	White office paper recycling program. Communicare involves persons with disabilities in the white paper recycling program.
Marion Co./Lebanon	Downtown recycling bins. City recycling facility at maintenance barn.
Meade Co.	Recycling drop off center staffed by volunteers. County road department transfers items to receiving station.
Kentuckiana ADD	
Henry Co.	Developing monthly drop off day for incorporated cities. Education programs.
Jefferson Co.	The county operates 2 drop off sites. The county tries to encourage recycling by small cities through cooperative agreements.
Audubon Park	Recycling ordinance. Program started.
Blue Ridge	Recycling study underway.
West Buechel	Once a week curbside collection.
Forest Hills	Starting once a week curbside collection.
Louisville	Curbside collection for 10,000 homes. Anti–scavenger recycling ordinance. Government white office paper recycling program.
Lyndon	Researched various recycling programs.
Robinswood	Curbside recycling. 95% participation rate.
Rolling Fields	Strong public support. To begin program.
Springlee	Once a week curbside pickup.
Winding Falls	Curbside pickup. Studying composting program.

ADD/County/City	Status of Efforts
Shelby Co./Shelbyville	Clean community program working with government and business to promote recycling.
Spencer Co.	Dropoff center for aluminum and glass.
Green River ADD	
Daviess Co./Owensboro	Composting and recycling committees have been formed.
Gateway ADD	
Rowan Co.	Involved in the formation of a county/city nonprofit recycling center.
Cumberland Valley ADD	
Rockcastle Co.	3 recycling centers established by fiscal court and privately operated are awaiting funding from ARC.
Knox Co.	Community group formed to encourage waste reduction.
Whitley Co./Williamsburg	Aluminum cans are recycled at city and fire department.
Big Sandy ADD	
ADD District	Working to set up a central sorting and storage site for Floyd Co. landfill.
Pike Co.	Review of recycling technology. Set up 6 drop off centers throughout county.
Buffalo Trace ADD	
ADD District	Regional committee working to set model program in Maysville.
Mason Co.	Recycling under study.
Bluegrass ADD	
ADD District	Preparing recycling plans for 17 counties. Regional recycling program started.
Anderson Co.	Cooperative recycling effort with Anderson Co. School Board.
Boyle Co./Danville	County/city operated drop off center.
Estill Co.	Office paper recycling at courthouse.
Fayette Co./Lexington	Pilot curbside recycling. Yard waste and horse manure compost project. Corporate recycling program.
Franklin Co./Frankfort	White paper recycling program. Brush chipping giveaway project reduced landfill volume by 17%.
Jessamine Co.	White paper recycling at courthouse. County newspaper shredding project. Set up drop off center.
Madison Co./Richmond	Pilot curbside recycling project.
Powell Co.	Recycling white goods and metal.
Scott Co.	School recycling education program.

**ADD—Area Development District*
Source: Environmental Quality Commission, Local Environmental Issues Survey, 1990-91

There are currently 88 known commercial recyclers in Kentucky, a decrease from 101 in 1989. DWM notes that all recyclers may not have responded to a 1991 recyclers survey, and there may be additional facilities in the state **(Fig. 33)**. Registered recyclers include the Kentucky Beverage Industry Recycling Program's (BIRP) 70 buy–back centers. Since 1980, these centers have purchased 263 million pounds of aluminum, 55 million pounds of glass, 1.6 million pounds of plastic, 174 million pounds of newspapers, and 7,000 pounds of bi–metal cans. BIRP has paid out $182 million during the last ten years to purchase recyclable materials.

There are seven composting facilities currently registered with the state. These facilities primarily compost yard wastes for sale, or for landfill cover. Since yard and food waste account for 30% of the municipal waste stream generated by weight, the number of composting facilities is expected to increase in Kentucky.

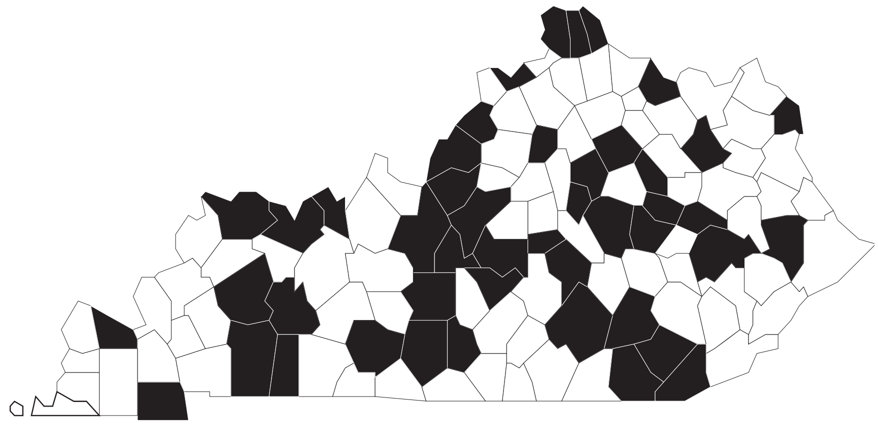
20% of the State's 155 Newspapers Use Recycled Paper; Old Telephone Books Collected in Three Counties

Old newspapers, which are some of the most recyclable materials, represent between four to five percent of Kentucky's municipal waste stream and about three percent of all wastes disposed in landfills. Nationally, the current recovery rate for newsprint is about 33%. Recycling of old newspapers in Kentucky is not known, but is minimal. Many private recyclers in the state are no longer accepting newspapers because markets for this waste are scarce. However, markets are predicted to improve during the next few years.

Recycled newsprint manufacturers are expected to double their demand for these materials by the end of 1992. This will create a market for about 40% of the old newspapers generated in the Southern U.S., according to a report prepared for the Kentucky Press Association in 1991. In Kentucky, using newsprint for animal bedding alone could reuse an estimated 30% of the papers generated in the state.

There are 88 known commercial recyclers in Kentucky. Seven composting facilities are also registered with the state.

Figure 33
Counties with Commercial Recyclers



Source: Kentucky Division of Waste Management, 1991

A study conducted by the University of Kentucky Extension Service found that a mixture of 75% newsprint and 25% straw did well for animal bedding. The study found that this use could reduce newsprint waste by 3.5 tons per stall each year in most horse bedding systems.

While Kentucky's newspapers are increasing their use of recycled newsprint, only an estimated 20% of the state's 155 newspapers presently use some recycled content. During the 1990 Kentucky legislative session, a measure promoting the use of recycled newsprint and less toxic inks was debated, but failed to pass. Some states have specified the use of recycled newsprint to assist in creating markets for newspapers. In Kentucky, only two newspapers are using soy-based ink for printing which is less toxic than oil-based ink.

At least three counties, Jessamine, Woodford, and Fayette, are collecting old telephone books for reuse. The project, called "Operation Redirect," is a joint effort between local governments, GTE, volunteers, and area waste haulers. Several drop–off points for the books were set up during the week of February 8–15, 1992. The project organizers report that participation has been better than expected and they hope to make it an annual event. Nearly 130 tons of old telephone books have been collected and will be sent to a company in Springfield, Kentucky for shredding and conversion to hydromulch, a material used to reclaim mine sites.

State Agencies Use Recycled Copy Paper; New Recycling Authority to Assist in Developing Markets

State government efforts to promote the use and collection of recycled materials have also increased over the past few years. DWM collected 2.9 million pounds of paper, plastic, glass, aluminum, and newspaper during 1990 at 125 state government offices.

Kentucky has had a voluntary state government recycling program for ten years. In 1990, however, Governor Wallace Wilkinson issued a directive to state agencies to recycle paper and use recycled materials where appropriate. Legislative action in 1990 also resulted in revisions to the state's procurement policies to encourage the use of recycled materials by state agencies. Products considered for state purchase must now be evaluated for recycled or recyclable quality. This has resulted in the purchase of recycled paper and products for state and local government use. All state agencies currently use recycled paper for copying. State regulations defining recycled content of paper, paper products, and some construction materials to be purchased by state agencies, and to promote the use of recyclable products in road and other state contracts, have been recently promulgated.

The state is attempting to promote the development of markets for recyclable materials. The Kentucky Recycling Brokerage Authority, a public corporation, was legislatively created in 1991 to help local governments develop markets for recyclables. But funding was not provided, which has limited the Authority's effectiveness.

Encouraging the public to produce less garbage and purchase reusable or recyclable products is essential for Kentucky to move forward in reducing the amount of solid waste sent to landfills. A statewide program to educate the public on the importance of reducing and properly managing wastes was mandated by the state in 1991. The program, to be developed jointly by the Natural Resources and Environmental Protection Cabinet, the Department of Education, and the Environmental Education Council, however, has been slow to materialize.

73% of Kentuckians Favor a Beverage Container Deposit Bill; Containers Account for 4-12% of Solid Waste Stream

A special legislative task force has reviewed the need for a state "bottle bill" to encourage recycling in Kentucky. A report was prepared for consideration in the 1992 legislative session. The task force commissioned a telephone survey to determine public support for a five or ten cent container deposit bill. Results indicate that 73% favor and 18% oppose such legislation, with the remainder undecided. Beverage containers account for 4% to 12% of the solid waste disposed at landfills and comprise much of the state's litter. Several previous attempts to pass a bottle bill in Kentucky have not been successful. A bottle bill which provided for centralized redemption centers was introduced in the 1992 General Assembly and supported by Governor Brereton Jones, but was withdrawn due to a lack of legislative support. Supporters plan to reintroduce the measure in the next legislative session.

National efforts to minimize product packaging may also assist state efforts to decrease the generation of solid waste. It is estimated that one–third of the solid waste stream consists of packaging. Some states have banned the use of heavy metals in packaging. The National Source Reduction Council, composed of industry, environmental, and state representatives, is developing a national policy to avoid piecemeal state laws on packaging. The council will consider standards to promote the following:

- Elimination of packages;
- Minimal packaging;
- Consumable, returnable, or refillable packaging; and
- Recyclable packaging.

Several bills on package design requirements to reduce wastes or encourage the use of recyclable products are currently under consideration in Congress.

In the meantime, Kentucky must move forward in developing a comprehensive strategy to reduce and recycle its wastes. This should include market development for recyclables and a strong state technical assistance and education program to promote source reduction, reuse, and recycling. Such an effort is critical if Kentucky is to meet its goal to reduce the weight of wastes disposed at municipal solid waste landfills 25% by 1997.

Open Dumps and Inactive Landfills

5,000 Open Dumps Pose Major Environmental Problems; Counties Struggle With Cleanups

At least 270,000 to 410,000 tons of garbage are illegally dumped or burned each year in Kentucky. This represents 10 to 20% of the state's municipal solid waste stream. In addition to being unsightly, illegal dumps cause problems with disease, odors, rodents, and birds. They also provide a direct route for toxic materials to contaminate ground and surface waters.

DWM estimates that more than 5,000 illegal dumps exist in Kentucky. For some residents, it is cheaper and easier to dump illegally than it is to dispose their wastes properly. The costs to taxpayers for cleaning up open dumps and litter are great. The cost to cleanup an open dump can range from $2,000 to $15,000. For example, in Bell County, 13 of the county's documented 256 open dumps were recently cleaned up at a total cost of $26,611. In addition, the state spends millions of dollars each year to remove roadside litter. Universal garbage collection programs, now active in 105 counties, should help prevent new dumps.

County solid waste plans must identify open dumps and establish a schedule for their cleanup. However, financing open dump cleanups will be a significant challenge. Some counties have used prison labor to clean up dump sites, and others have required dumpers to remediate the sites through court orders. Additional revenue sources are needed if counties are to address these problem sites and prevent new ones.

The Kentucky Transportation Cabinet's Adopt–a–Highway effort has been quite successful in reducing roadside litter and trash. Currently, 2,085 groups have adopted 12,397 miles of roadways. This represents 48% of the state–maintained highways. Kentucky's Adopt–a–Highway program is ranked second in the nation of the 46 states with these programs.

Sixteen Kentucky communities have certified Clean Community Programs designed to develop a systematic approach to solid waste management at the local level. DWM plans to implement a state program modeled after the national Clean Community Program to encourage additional county participation. Community efforts, such as the Ohio River, Kentucky River, and other stream and roadside cleanups, have actively involved the public in addressing local environmental problems while cleaning up the countryside.

626 Inactive Landfills Threaten Environment; Investigations and Cleanups Progress Slowly

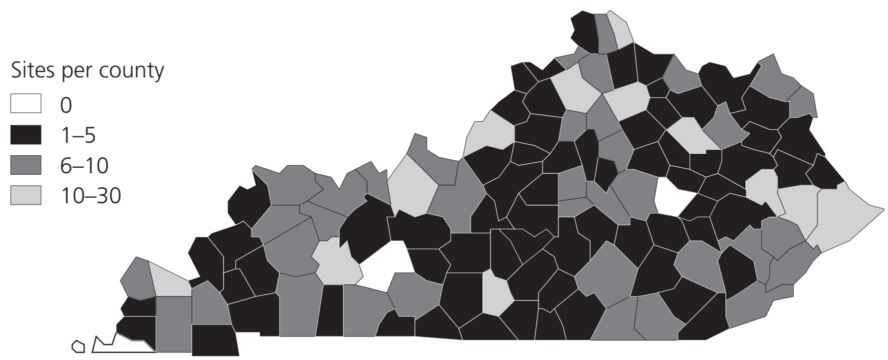
Kentucky has identified 626 old, inactive solid waste landfills and sewage landfarming operations scattered across the state which may be contaminating the environment **(Fig. 34)**. Many of these sites pose a significant threat because they operated before standards required liners and groundwater monitoring. Additionally, there were no restrictions on the types of wastes accepted and disposed. Forty of these sites are currently under investigation by the U.S. EPA and the state. The rest are awaiting investigation. Additional funding and resources are urgently needed to investigate, prioritize, and track the cleanup status of inactive solid waste sites in Kentucky.

4 Million Used Tires Generated Annually; Tire Fee Raises $334,000 to Fund Cleanup, Research

Waste tire dumps pose significant health and environmental threats. An estimated 4 million used tires are discarded each year in Kentucky. Many of these tires wind up in piles scattered across the state, providing breeding grounds for mosquitoes that can carry infectious disease. One such pile in Alexandria in Campbell County has an estimated eight million tires spread over ten acres. The illegal burning of tires is a continuing problem, causing air pollution and the release of toxic contaminants to surface and groundwaters. DWM is currently inventorying waste tire piles and has estimated they number in the hundreds.

Kentucky has identified 626 old inactive landfills and landfarm sludge operations scattered across the state. Forty are under investigation by the U.S. Environmental Protection Agency. The rest are awaiting investigation.

Figure 34
Inactive Landfills in Kentucky*



**Based on 626 inactive solid waste landfills and sludgefarming operations*
Source: Kentucky Division of Waste Management, 1991

A 1990 state law seeks to address the waste tire problem by requiring all waste tires disposed in permitted solid waste landfills to be cut or shredded prior to disposal. A $1 state fee on all new replacement tires sold in Kentucky went into effect on January 16, 1991 to promote proper tire disposal. Tire distributors with contracts for the lawful disposal of waste tires can apply for an exemption from the fee. As of September 1991, 698 distributors had received an exemption from the tire fee and 82 applications were pending.

The tire fee generated approximately $434,000 in 1991. Approximately $108,500 has been placed in a low interest loan program to fund research and development for tire disposal, to foster tire collection and proper storage, and to assist owners with more than 500 tires to remove or develop a use for those tires. Another $226,000 has been placed in a cleanup fund to be used by the state or local governments to address waste tire piles. Approximately $100,000 from the fund was allocated to the Revenue Cabinet to cover administrative costs to collect the fee. No loans have been awarded pending the development of regulations for their dispersal. Many tire distributors also charge an additional tire disposal fee ranging from $.65 to $2 per tire.

The cleanup fund will not likely generate the money needed to effectively address the hundreds of waste tire piles in Kentucky. The inappropriate use of the fee may also discourage proper tire disposal. For example, there have been some reports that tire distributors are charging optional disposal fees, giving customers the choice to dispose the used tires themselves. Other concerns have been expressed that some tire distributors and landfills may be overcharging customers for tire disposal. It has also been reported that some dealers are identifying their disposal fee as a state tax, even though they are exempt from the $1 state tire fee.

Currently, there are ten private tire processors operating in Kentucky. Two facilities cut tires for fuel and the remainder process tires for disposal in landfills. Efforts to develop new uses and markets are needed if tires are to be diverted from landfills. More than 35 tire recycling firms have considered locating in the state, however, high capital investments have been a major constraint, as are the low costs of landfilling waste tires. The state's loan and research program may assist in finding alternatives for waste tire disposal.

Industrial Solid Wastes

While the number of municipal solid waste landfills are declining, the state is permitting an increasing number of industrial solid waste landfills. Kentucky industries have moved toward disposing their own wastes in on–site landfills. Forty-three solid waste landfills are currently permitted in Kentucky to receive inert wastes (construction/demolition debris) or residual wastes (industrial waste and by–products). In 1974, 23 of these industrial landfills were permitted. A majority of inert or residual landfills are privately owned and operated.

The steady increase in the number of industrial solid waste landfills is a reflection of a growing waste stream. Industrial pollution control technologies have generally created waste by–products. Much of this waste is disposed in residual landfills at the source where it was generated. It is not known how much industrial solid waste is generated and disposed in Kentucky since reporting is not required. Industrial growth and declining municipal landfill space will continue to create a demand for these disposal facilities.

34 of 43 Inert/ Residual Landfills Have Groundwater Monitoring Plans; Two of Four Reporting to State Detect Groundwater Contamination

Industrial solid waste landfills will be repermitted or closed by June 1992 under the state's new solid waste regulations. Many inert landfills operating in Kentucky (which will no longer be permitted under the state's new solid waste regulations) are converting to construction/demolition debris landfills or residual landfills in order to accept industrial waste by–products. Eighteen proposed construction/demolition debris waste landfills are under state review, 15 of these are for less than one–acre. Residual landfills must meet environmental performance standards established under state regulations. All residual landfills will be required to monitor groundwater by July 1992. (Thirteen residual landfills that accept fly ash and scrubber sludge will be repermitted as special waste landfills, which are discussed further in the Special Waste Section.) Currently, 34 residual and inert landfills have groundwater monitoring plans or wells, but it is not known how many are presently monitoring groundwater quality.

DWM received groundwater monitoring reports from only four residual or inert landfills during the first quarter of 1991. Two of the four detected various levels of contamination. The contaminants found included iron, manganese, sodium, and lead. The U.S. EPA is expected to establish national standards for the construction and operation of residual landfills within the next few years.◆

Special Wastes

Special wastes are defined as those wastes of high volume and low hazard which include but are not limited to mining wastes, electric-generating utility wastes (fly ash, bottom ash, scrubber sludge), sludge from water and wastewater treatment facilities, cement kiln dust, gas and oil drilling muds, and oil production brines. These wastes make up a significant amount of the waste generated and disposed in Kentucky. Most special wastes are disposed in landfills, injection wells, ponds, or reused for a variety of purposes.

Regulation of special wastes in Kentucky has long been an issue, due to the large amount of waste produced and the economics of its disposal. Prior to 1991, special wastes were regulated as solid wastes. The 1991 General Assembly, however, required the development of special waste regulations. These regulations are expected to be finalized in 1992.

Landfarming Sewage Sludge Expected to Increase Due to Landfill Costs; 52 Landfarm Operations Currently Permitted in 38 Counties

Kentucky currently permits 3,994 wastewater treatment plants. A by–product created by treating wastewater is sludge. Sludge, which is considered a special waste, can be either disposed in solid or residual waste landfills, spread over land (known as landfarming), or composted. DWM requires sludge to be tested to determine the level of hazardous constituents prior to its disposal in a landfill.

Interest in landfarming is increasing due to higher landfill costs as well as unavailable capacity. Landfarmed or composted sludge must be tested for metals and other constituents. DWM requires permits for landfarming sludges with elevated levels of metals. Currently, 52 landfarming operations are fully permitted, and six are under review. There are also certain land use restrictions where sludge is applied, particularly on crop and pastureland.

Landfarming operations with "clean sludge" are required to register with the state. In 1990, a total of four operations were registered. In 1991, the number of registered landfarm operations increased to 11. Fourteen landfarm operation registrations are currently under review. These operations are subject to fewer monitoring and public notice requirements than sites subject to full permits, but must test their sludge and submit annual reports.

Fly Ash, A Special Waste Generated by Power Plants, Disposed in Eight Landfills, 50 Ponds

Fly, or bottom ash, is a special waste that is generated in large amounts as a result of burning coal as fuel at 58 power plant units and two industrial facilities in Kentucky. Fly ash contains toxic constituents and must be tested to determine if it qualifies as hazardous waste and requires disposal in a hazardous waste landfill. Ash that does not meet the toxicity level necessary to classify it as a hazardous waste may be disposed in residual waste landfills, ponds, or may be reused for road base and building materials.

There are 13 residual and inert landfills permitted in Kentucky to accept fly ash and scrubber sludge. These landfills are required to meet environmental performance standards and will be repermitted as special waste landfills. Most fly ash, however, is disposed in ponds while it is still wet. Fly ash ponds are "permitted–by–rule," meaning they are automatically permitted by DWM. As with residual landfills, these ponds must meet environmental performance standards to control soil and water contamination. Fly ash ponds are also permitted by the Kentucky Division of Water. It is estimated that there are 50 fly ash ponds in the state. The extent to which these facilities are impacting groundwater is not known since groundwater monitoring is not currently required.◆

Medical Wastes

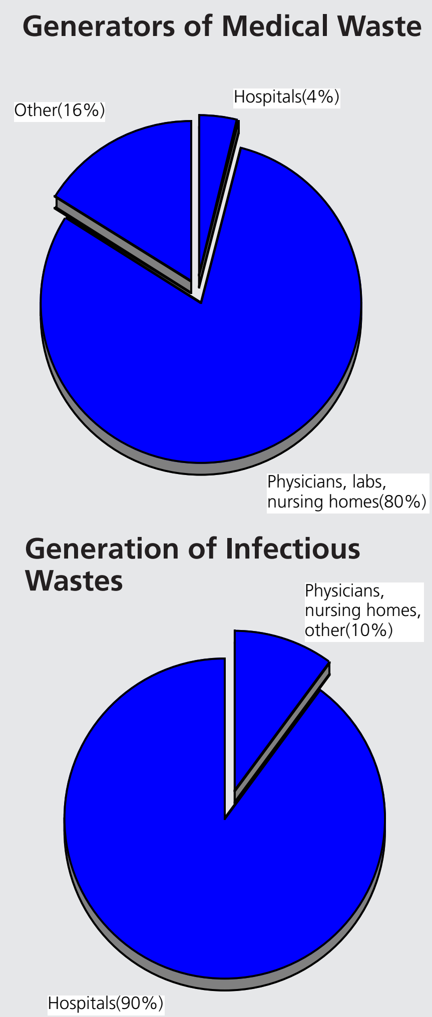
Medical waste is produced by hospitals and other health care facilities. According to the U.S. EPA, about 80% of the medical waste generators are physicians, dentists, laboratories, nursing homes, and veterinarians which each produce less than 50 pounds of medical waste per month. While the U.S. EPA indicates that hospitals comprise only 4% of the medical waste generators, they produce about 90% of the infectious waste **(Fig. 35)**. The Kentucky Hospital Association (KHA) estimates that hospitals generate from 13 to 15 pounds of medical waste per patient each day.

Hospitals Produce 90% of Infectious Waste; 6.8 Million Pounds Generated in State During 1989

Approximately two pounds of the hospital waste generated daily is defined as “red bag" infectious waste. Infectious waste includes discarded needles, blood and pathological blood by–products, and microbiological laboratory wastes. Based on the KHA generation rate and the 1989 average daily hospital census of 9,320 patients, an estimated 44 to 51 million pounds of hospital medical wastes are generated yearly in Kentucky, of which 6.8 million pounds are considered infectious waste.

Most medical waste generated by hospitals is disposed in solid waste landfills. Infectious waste, however, requires special treatment. Microbiological laboratory waste must be rendered nonhazardous by incineration, autoclaving, or a technology of equal effectiveness. Pathological wastes must be incinerated. A 1989 DWM survey of 213 small generators of infectious waste revealed that 53% ship this waste off–site to be treated. The most common off–site treatment was incineration (22%). Another 24% of survey respondents indicated that their infectious waste was transported directly to a landfill, and 45% stated that they put treated or untreated waste into dumpsters for pickup.

Figure 35
Medical Waste Generation



Source: U.S. Environmental Protection Agency, 1991

The U.S. EPA indicates that hospitals account for only 4% of the medical waste generators but produce 90% of the infectious waste. Kentucky hospitals produce about 6.8 million pounds of infectious waste each year. Most is burned at small hospital incinerators.

Medical Waste Incinerators to Meet Stricter Air Emission Standards by 1994

KHA conducted a survey of hospitals in 1990 and found that 44 of the 108 acute care facilities in Kentucky were operating medical waste incinerators. This survey did not include federal and state hospitals, university hospitals, or Humana hospitals which are not KHA members. The 44 incinerators are geographically distributed and operated by both small and large hospitals. While units range in size, all have the capacity to incinerate 500 pounds per hour or less, with the exception of Medigen in Louisville which is Kentucky's only commercial medical waste incinerator.

The state revised its air pollution regulations in 1991 to require additional controls on medical waste incinerators. The new rules require solid and medical waste incinerators to meet more stringent requirements for particulates, and dioxin, furan, hydrogen chloride, sulfur dioxide, nitrogen dioxide, and carbon monoxide emissions by December 31, 1994. The regulations also require a 40% reduction in the amount of waste burned. According to the Kentucky Division for Air Quality and KHA, most medical waste incinerators will require modification to meet the new air emission standards. To date, no facilities have applied for a permit under the new rules. It is expected that some of the smaller hospital medical waste incinerators may close due to the costs of meeting the standards, resulting in fewer but probably larger medical waste incinerators in Kentucky.

In 1989, a state infectious waste task force recommended additional requirements to collect, store, transport, and manage infectious waste. These recommendations are under consideration by the Department for Environmental Protection and the Cabinet for Human Resources.◆

Low–Level Radioactive Waste

While Kentucky only generates a limited amount of low–level radioactive waste, the state is all too familiar with the threats these wastes pose to the environment and public health. In 1963, Kentucky permitted the second commercial low–level radioactive waste disposal site in the nation. The Maxey Flats Low–Level Radioactive Waste Site, located in Fleming County, was expected to attract nuclear energy industrial facilities to the region. However, the site attracted no industries. It was closed 13 years later after radioactive contamination was discovered migrating off the 27–acre site. The risks posed by the Maxey Flats site will remain with the community for hundreds of years.

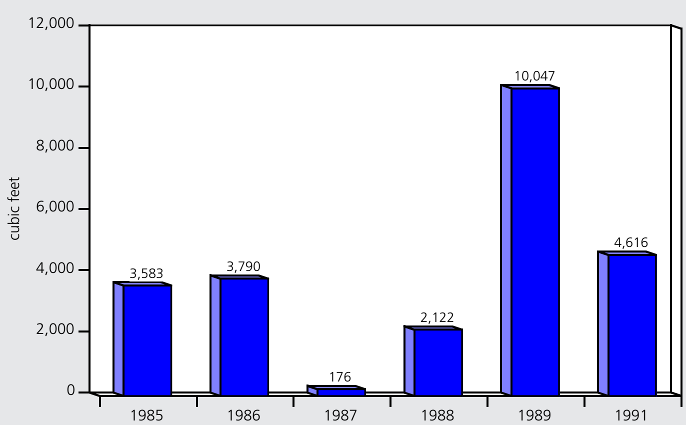
378 Facilities Licensed to Receive, Handle Low–Level Radioactive Waste; 10,000 Cubic Feet Reported Disposed in 1989

In 1989, more than 10,000 cubic feet of low–level radioactive waste produced by universities, hospitals, laboratories and other facilities in Kentucky were sent out–of–state for disposal.

The Radiation Control Branch of the Kentucky Cabinet for Human Resources currently licenses 378 facilities to receive, handle, and dispose low–level radioactive waste. In addition, the Branch has issued 48 registrations for facilities involved in nuclear medicine. Another 325 general licenses have been issued for minor uses of low–level radioactive materials.

During the past six years, the amount of low–level radioactive waste produced in the state and disposed has varied from a low of 176 cubic feet in 1987, to a high of 10,047 cubic feet in 1989 **(Fig. 36)**. The increase in 1989 may be due to an accumulation of waste stored prior to its disposal. In 1990, about 97.5% of the radioactive waste generated in Kentucky was produced by government agencies, 1.9% was industrial, and 0.6% was from academic institutions.

Figure 36
Low–Level Radioactive Waste Generated in Kentucky and Disposed*



**as reported by disposal site operators*
Note: Does not include low level waste produced by the U.S. DOE uranium enrichment plant in Paducah. In 1989, this plant produced 6,700 cubic feet of low–level radioactive wastes. These wastes and more than 80,000 cubic feet of previously generated radioactive wastes are stored on–site.
Source: Kentucky Radiation Control Branch, 1992

The state licenses 378 facilities to receive, handle, and dispose low–level radioactive wastes. These wastes are sent out–of–state to Washington, Nevada, and South Carolina for disposal.

These production estimates do not include the state's largest generator of low–level radioactive waste, the U.S. Department of Energy's Gaseous Diffusion Plant in Paducah. This facility is exempt from state radioactive materials licensing procedures and is regulated by the U.S. Department of Energy (DOE). Approximately 6,700 cubic feet of low–level radioactive waste were generated at the plant in 1989. At present, all the low–level radioactive waste produced at the plant is stored on–site. The waste inventory at the plant includes 28,724 cubic feet of low–level radioactive wastes and 52,505 cubic feet of PCB/radioactive wastes. The U.S. DOE plans to begin shipping the low–level radioactive waste to the state of Washington in 1992 for disposal.

All Low–Level Radioactive Waste Disposed Out–of–State; 90% Sent to Hanford in Washington State

About 90% of the low–level radioactive waste generated in Kentucky is sent to Richland, Washington for disposal at the Hanford Low–Level Radioactive Waste Site. Another 5.6% is shipped to Beatty, Nevada and 4.4% to Barnwell, South Carolina. (This does not include waste generated at the Paducah Gaseous Diffusion Plant.)

In 1984, Governor Martha Layne Collins signed an Executive Order entering Kentucky into the Mid–West Low–Level Radioactive Waste Compact with the State of Illinois. The compact was approved by the Kentucky legislature in 1986. Under the agreement, Illinois will dispose both Kentucky and Illinois generated wastes. The two states generate an estimated 144,893 cubic feet of low–level radioactive waste annually. Approximately 6.9% of this total is produced by Kentucky. Illinois is currently in the process of siting a low–level waste disposal facility.

Radioactive Contamination

Radioactive Contamination Detected at Paducah Gaseous Diffusion Plant; Study Underway to Determine Extent

In August 1988, the Radiation Control Branch detected radioactive contamination above U.S. Environmental Protection Agency (EPA) limits in four private water wells north of the Paducah Gaseous Diffusion Plant. Later, two more wells were found to be contaminated.

The plant, located on a 1,350-acre site, enriches uranium for use as fuel in commercial nuclear reactors and for propulsion in Navy nuclear vessels. The radioactivity was determined to be technetium–99 (Tc–99), a radionuclide which does not occur naturally. Tc–99 is a fission product associated with fuel rods. It entered the waste stream from reprocessed fuel. The facility stopped handling reprocessed fuel, and U.S. DOE provided residents whose wells were contaminated with hookups to public water supplies. The agency also intends to provide public water to 30 other homes in the area in the near future.

A Consent Order was signed in November, 1988, between the U.S. EPA and the U.S. DOE directing U.S. DOE to characterize and evaluate the spread of contamination at the Paducah plant. The U.S. DOE has completed a two–phase study of the contamination. The second phase was submitted to the U.S. EPA and the Commonwealth of Kentucky for review and comment in late October 1991. The study revealed contamination in 30 of the 336 monitoring wells tested. The plume of contamination is thought to be moving toward the Ohio River. State officials predict that the cleanup at the plant may be the most lengthy and costly for a contaminated waste site in Kentucky.

The state also entered into an Agreement in Principle in June 1991, with the U.S. DOE to fund expanded state oversight and monitoring activities at the plant. The Kentucky Radiation Control Branch is in the process of expanding its activities in this area. This may require as much as a year to implement, due to the requirements for staffing, training, and purchasing necessary equipment.

State Requests Greater Oversight Role in Monitoring On–Site Activities at Uranium Enrichment Plant

In addition to detecting Tc–99 in groundwater, sediment, surface water, soil, and vegetation, the Kentucky Radiation Control Branch and the U.S. DOE detected the presence of uranium in the shallow groundwater system adjacent to a uranium burial area on–site at the Paducah Gaseous Diffusion Plant. The presence of a soluble form of uranium in water in the shallow groundwater systems indicates the potential for further contamination of the regional aquifer. The U.S. DOE removed the monitoring well where the contamination was found, thus limiting the investigation of the mobility and the species of uranium present. The Kentucky Radiation Control Branch protested the removal of this well. The Branch continues to assert that the U.S. DOE has not conducted the appropriate studies to evaluate the presence and mobility of uranium in the groundwater system.

Because of significant problems at the Paducah plant, it is important for the state to increase oversight of this facility regarding radiological activity—both on and off–site. The Radiation Control Branch believes the U.S. DOE has not properly addressed environmental concerns, or health and safety issues related to plant workers.

Remediation at Maxey Flats Radioactive Waste Site to Take Up to 100 Years; Will be Monitored in Perpetuity

The Maxey Flats Low–Level Radioactive Waste Disposal site operated in Kentucky from 1963 to 1977. The site received 4.5 to 6.0 million cubic feet of low–level radioactive waste, which were disposed in 52 shallow trenches. The detection of radioactive contamination in groundwater both on and off–site led to its closure in 1977. In 1978, the Commonwealth of Kentucky assumed ownership of the site and has maintained it since. The site was placed on the federal Superfund list of the worst waste sites in the nation in 1986.

After years of study, in 1991 the U.S. EPA announced that an initial 21–inch soil and plastic cap will be constructed at the Maxey Flats site. The site will then be allowed to settle for the next 35 to 100 years. A final multi–layer cap with a synthetic liner would be installed at the completion of natural subsidence. The burial trenches would then form a stable foundation for the final cap, according to the study plan. The design of the final cap will reflect the most advanced technology and a monitoring and surveillance program would then be funded in perpetuity.

The closure of the site is estimated to cost $33.5 million. This includes the possible installation of a barrier wall to prevent groundwater infiltration into the site and the purchase of a buffer zone around the site. Surface water, groundwater, vegetation, and soil monitoring will be conducted at the site during the 35 to 100 year settling period. Five–year reviews will be conducted.

More than 800 parties disposed wastes at Maxey Flats. The U.S. EPA is currently negotiating with the principle responsible parties, which include research laboratories, government agencies, health care facilities, manufacturing companies, and nuclear power plants, to carry out the remediation plan.

The Maxey Flats Concerned Citizens group was formed in 1988 to monitor activities at the site. The group was the first in the U.S. EPA Southeastern Region, and second in the nation, to receive a $50,000 Technical Assistance Grant from the U.S. EPA to review closure alternatives and offer comments. The group hired a nuclear physicist as its technical advisor and offered extensive comments on the U.S. EPA's proposed closure plan. The Maxey Flats Concerned Citizens group has expressed continued concern about institutional controls for future site security and adequate funding for the perpetual maintenance and monitoring of the site.

Radioactive Contamination in Oil Sludge Pits Poses Public Health Risks; Investigations Underway

The state and the U.S. EPA have recently discovered that many pits in Kentucky used to dispose oil sludge may be contaminated with high levels of radium and uranium. These naturally occurring radionuclides are technologically enhanced during the drilling process and become concentrated in the oil sludge collected in storage tanks. Much of this sludge was later disposed in pits. It is not known how many oil sludge pits exist in Kentucky, although at least 50 pits used by Ashland Oil, Inc. are located in the Martha Oil fields in Johnson and Lawrence counties.

Ashland Oil was ordered to clean up these pits under a Consent Decree entered into with the U.S. EPA in November 1987. Ashland reclaimed seven pits (which involved landfarming and backfilling), however, the cleanups were halted after it was discovered in 1991 that high levels of radioactivity were present in the sludge. The Kentucky Radiation Control Branch is in the process of developing regulations to address the storage and disposal of naturally occurring radioactive substances and wastes. The U.S. EPA is also in the process of developing recommended cleanup standards and procedures for contaminated oil sludge pits.

The greatest risks posed by these sites are public health threats from exposure to radioactivity. According to state officials, risk assessments revealed a one in 100 cancer risk near some contaminated sludge sites. Louisiana recently enacted a cleanup standard of 5 picocuries per gram. Tests at the unreclaimed Ashland Oil sludge pits revealed levels as high as 2,000 picocuries per gram. Texas now requires all oil sludge contaminated with naturally occurring uranium and radium to be shipped to the nation's only disposal facility located in Utah. There are no such disposal requirements currently in effect in Kentucky.

The environmental and health impacts from these sites may be significant in Kentucky, particularly to people living near pits or in areas where this waste was landfarmed or used as fill material. There is a critical need to inventory and clean up oil sludge pits in Kentucky. With over 20,000 oil drilling operations in the state, it is also vital that proper procedures be established for the safe disposal of oil sludge waste.◆

Chapter 4

Toxics

Toxics

Millions of pounds of toxic chemicals are released each year into Kentucky's air, land and water. To better determine the impacts of toxic chemical releases on the environment, in 1986 Congress passed the Superfund Amendments and Reauthorization Act (SARA) which included the "Emergency Planning and Community Right–to–Know Act." The act requires certain manufacturers with ten or more employees to report emissions and transfers of certain toxic chemicals produced or used during the year. Access to this information must now be provided to the public. The act also requires each state and county to establish emergency response commissions and develop local plans. In Kentucky, all counties have developed local emergency response plans to better prepare for environmental accidents involving dangerous chemicals.

Toxic releases and state and private sector efforts underway to reduce them are reviewed in this chapter. It should be noted that the comparison of the 1988 through 1990 toxic inventory data may not accurately reflect emission trends because of changes in reporting requirements, improper or inaccurate reporting by some industries, as well as an increase or decrease in the number of facilities reporting. This chapter does, however, provide a general "snapshot" of toxic releases in Kentucky, and the media to which they are released into the environment.

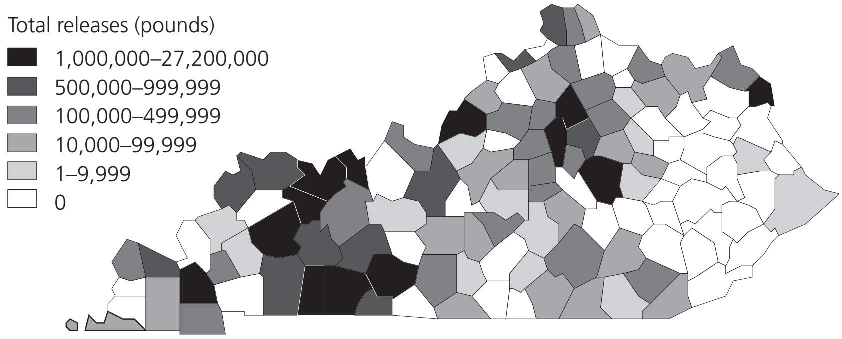
Toxic Releases

80% of Reported Toxic Releases Occur in 18 Counties; Majority Emitted by 25 Industrial Facilities

In 1990, 78.8 million pounds of toxic chemicals were reported released or transferred into Kentucky's environment. Thirteen counties received toxic emissions ranging from one million to more than 27 million pounds **(Fig. 1)**. Combined, these 13 counties received 80% (63 million pounds) of all reported releases in the state. Most releases occurred in Jefferson, Marshall, McLean, Boyd, and Woodford counties. Ten chemicals accounted for 70% of all releases in 1990 and include: hydrochloric acid, toluene, aluminum (fumes or

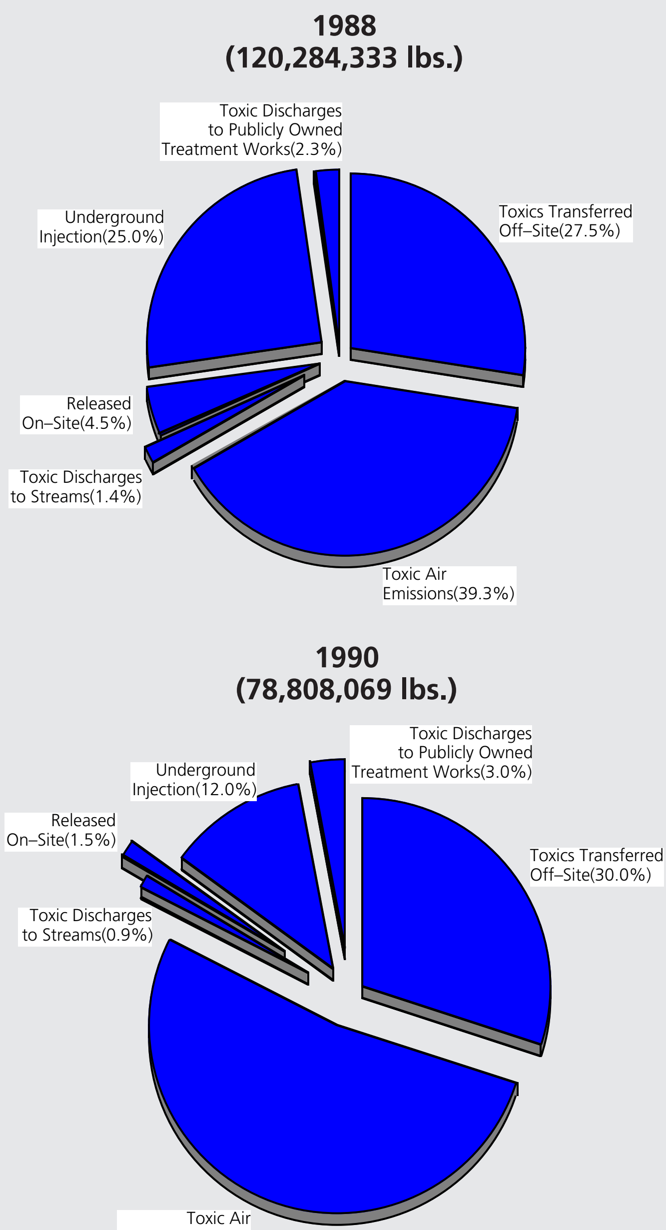
Thirteen counties received toxic releases/transfers of one to 27 million pounds in 1990. The five counties with the greatest releases were Jefferson, Marshall, McLean, Boyd, and Woodford.

Figure 1
Toxic Releases to Land, Air and Water from Reporting Sources (1990)



Source: Kentucky Department for Environmental Protection, Toxic Chemical Release Inventory Data,1990 dust), xylene (mixed isomers), methanol, acetone, ammonia, 1,1,1–trichloroethane, glycol ethers, and ethylene. About 50% of the state's reported industrial toxic emissions in 1990 were released into the air **(Fig. 2)**.

Figure 2
Industrial Toxic Releases and Transfers in Kentucky



Source: Kentucky Department for Environmental Protection, Toxic Chemical Release Inventory Data,1988-1990

More than 50% of the state's toxic emissions were released into the air in 1990, an increase in proportion since 1988 when 39% were air releases. The decline in underground injection of toxic chemical wastes is due to the generator finding a market for this substance.

The amount of toxic releases/transfers in 1990 was 34.5% less than the 120.3 million pounds reported in 1988 **(Fig. 3)**. The decrease in reported releases is due to better understanding of reporting requirements, more accurate reporting, a trend to avoid using reportable chemicals, and reductions achieved through process changes. During 1988 and 1989, 16 of the more than 300 reporting facilities released 70% of the toxic releases. In 1990, 25 facilities released 71% of the reported toxics **(Fig. 4)**. Approximately 80% of all toxics emitted in 1990 were emitted in 13 counties—Jefferson, Marshall, McLean, Boyd, Woodford, Hancock, Scott, Logan, Warren, Daviess, Todd, Madison, and Hopkins.

These totals do not include the toxics released by many smaller companies who are not required to report, or as a result of transportation spills. In 1990, for example, 78% of the 1,777 emergencies responded to by the state during 1990 involved hazardous and toxic substances, many of which were the result of transportation accidents.

Figure 3

Toxics Released by Reporting Industries to Land, Air, and Water in Kentucky

Releases/Transfers (pounds)	1988[1]	1989	1990[2]
Total Air Emmissions	47,203,709	44,879,849	41,461,167
Fugitive	15,265,086	12,989,946	11,525,889
Stack	31,938,623	31,889,903	29,935,278
Stream Discharges	1,701,027	791,963	736,679
Total On–Site	5,492,005	646,414	1,203,265
Landfills	5,149,368	550,206	1,164,377
Land Treatment	9,642	1,904	631
Impoundments[3]	174,140	91,805	30,340
Other	158,855	2,499	7,917
Underground Injection	30,000,000	39,000,000	9,447,843
Transfers			
Municipal WWTPs[4]	2,778,294	2,605,736	2,319,401
Off–Site Transfers	33,109,298	24,469,556	23,639,723
Total Reported	**120,284,333**	**112,393,518**	**78,808,069**
Number of Reporting Facilities	**335**	**368**	**400**

[1]1988 data do not include aluminum oxide and sodium hydroxide solution (total 40 million lbs.) which were delisted for 1989.

[2]1990 data include 1.16 million pounds of toxic chemicals that were not previously required to be reported.

[3]Impoundments include pits, ponds, and lagoons used for storage or final disposal of toxic substances.

[4]Industrial wastewater discharges transferred to municipal wastewater treatment plants.

Source: Kentucky Department for Environmental Protection Toxic Chemical Release Inventory Data,1988-90.

The amount of toxic transfers and releases reported by Kentucky industries decreased 36% between 1988 and 1990. This is due to better reporting, a trend to avoid using reportable chemicals, and reductions acheived through process changes.

Figure 4

Top 25 Kentucky Industrial Facilities with Toxic Releases/Transfers

Company	County	(State Ranking) and Total Pounds 1989	1990
Dupont	Jefferson	(1) 40,213,058	(1) 10,554,142
Barmet Aluminum	McLean	(2) 6,851,181	(2) 7,693,050
American Synthetic Rubber	Jefferson	(4) 5,443,330	(3) 5,292,197
Air Products and Chemicals	Marshall	(3) 5,591,750	(4) 4,914,127
Westlake Monomers	Marshall	*	(5) 4,123,511
Armco Steel	Boyd	(8) 1,972,653	(6) 2,328,755
GTE Products	Woodford	(7) 2,387,813	(7) 2,279,531
Hi–Tek Polymers	Jefferson	(12 1,498,792	(8) 2,189,562
Toyota Motor	Scott	(15) 1,261,840	(9) 2,126,465
Rohm & Haas	Jefferson	(44) 358,857	(10) 1,325,882
Commonwealth Aluminum	Hancock	(11) 1,700,380	(11) 1,315,416
GE Appliances	Jefferson	(14) 1,451,150	(12) 1,180,178
E.R. Carpenter	Logan	(16) 1,080,210	(13) 1,164,205
Koppers Industries	Todd	(260) 4,056	(14) 1,138,931
Standard Gravure	Jefferson	(13) 1,489,500	(15) 1,052,250
Imco Recycling	Butler	(168) 30,135	(16) 992,250
Akzo Coatings	Jefferson	(30) 531,427	(17) 846,069
Armco Steel - Coke Plant	Boyd	(22) 782,271	(18) 820,740
Ensign–Bickford	Muhlenberg	(23) 725,800	(19) 761,005
General Motors	Warren	(32) 482,442	(20) 729,945
Ahlstrom Filtration	Hopkins	(26) 664,942	(21) 728,382
ISP Chemicals	Marshall	(17) 953,197	(22) 680,085
Ashland Petroleum	Boyd	(19) 877,002	(23) 649,612
Dow Corning	Carroll	(18) 887,486	(24) 642,874
Brown Printing Co.	Simpson	(36) 449,203	(25) 631,023
Total 25	**14**	**77,688,475**	**56,160,187**

**Assumed ownership in 1990*

Source: Kentucky Department for Environmental Protection, Toxic Chemical Release Inventory Data, 1988-90.

Twenty–five facilities in 14 Kentucky counties reported approximately 71% of all toxic chemical releases and transfers in 1990.

Facilities that store extremely hazardous substances (many of which are also toxic) in certain quantities must have emergency plans approved by the state to minimize risks associated with accidents. During 1991, 875 facilities had plans approved. These facilities include municipal plants, schools, industries, and others. About 75% of the 875 plans were for industrial facilities. Industries which store hazardous substances that are not considered extremely hazardous are exempt from the requirement to submit emergency plans, but must report the amount they store if it exceeds 10,000 pounds. In 1991, 2,813 industries reported storing at least 10,000 pounds of these substances.

On–Site Toxic Releases Decline Due to Closure of Hazardous Waste Impoundments; Some Impoundments Used to Dispose or Store Toxics Need Additional Attention

There are six basic ways in which toxics are released: air emissions, stream discharges, on–site in the land, underground injection, discharges to wastewater treatment plants, and off–site transfers.

On–site toxic releases decreased from 5.4 million pounds in 1990 to 1.2 million pounds in 1990, which is illustrated in Figure 3. This decline was attributed to the closure of surface impoundments previously used to dispose hazardous wastes, and the shift to sending these materials off–site rather than landfilling on–site. Twenty-four surface impoundments in Kentucky were closed as a result of the U.S. EPA's "land ban" on the disposal of hazardous waste unless a facility became permitted for disposal.

However, impoundments used to dispose or store toxic materials or industrial process waters containing toxics are still in use at several facilities in the state including Middlesboro Tannery in Bell County, Rohm and Haas in Jefferson County, North Star Steel in Marshall County, the Paducah Gaseous Diffusion Plant in McCracken County, and the Somerset Refinery in Pulaski County. Discharges to these impoundments are regulated by the Division of Water. The environmental impacts of these impoundments, however, are unknown since groundwater monitoring is not required and state construction and operating standards have also not been developed for these types of facilities. More attention to these impoundments is needed to identify problems and ensure their proper construction and operation.

On–site toxic releases reported in Kentucky nearly doubled between 1989 and 1990, rising to 1.2 million pounds due to the addition of creosote on the list of reportable chemicals, and one facility landfilling aluminum dross containing ammonia. The amount of toxic substances transferred off–site in Kentucky declined from 33 million pounds in 1988 to 23.6 million pounds in 1990, due primarily to better reporting.

The decrease in toxics discharged to Kentucky streams, from 1.7 million pounds in 1988 to 736,679 pounds in 1990, is also largely due to more accurate reporting. Several facilities reported discharges of acids or bases in neutralized wastewater during 1988 that should not have been reported. The 1989 and 1990 data reflect this correction.

Highly Toxic Emissions Account for 32% of 78.8 Million Pounds Released in 1990

Many of the toxic releases reported by industrial sources involve chemicals that are known or suspected to cause cancer and other serious health affects. Of the 112.4 million pounds of toxics released in Kentucky during 1989, 26.8 million pounds (24%) were 17 chemicals that the U.S. Environmental Protection Agency (EPA) has prioritized for emission reductions because they are highly toxic. In 1990, 31.8% (25 million pounds) of the reported releases/transfers in Kentucky were considered highly toxic or known or suspected carcinogens **(Figs. 5 and 6)**. Sixty percent of the 41.5 million pounds of the toxics released to the air in 1990 were considered highly toxic.

Figure 5
Highly Toxic Chemical Releases in Kentucky

Pollutant (pounds)	1988	1989	1990
Benzene	548,800	544,078	661,341
Cadmium and	1,655	250	5
compounds	101,201	8,177	51,749
Carbon Tetrachloride	30,931	32,412	13,208
Chloroform	513,557	325,335	234,080
Chromium and	2,609,033	111,004	50,548
compounds	295,777	202,048	134,324
Cyanide compounds	84,293	39,934	45,136
Dichloromethane (Methylene Chloride)	1,536,888	1,491,154	1,404,288
Lead and	602,101	527,714	81,925
compounds	695,642	766,868	502,265
Mercury	12,247	26,066	13,217
Methyl Ethyl Ketone	1,271,130	1,599,970	1,767,400
Methyl Isobutyl Ketone	990,272	1,420,688	937,592
Methylchloroform (1,1,1–Trichloroethane)	2,684,011	2,289,791	2,327,608
Nickel and	155,201	126,275	95,429
compounds	132,656	154,387	214,919
Perchloroethylene	586,847	744,507	585,180
Toluene	11,565,364	10,161,578	9,464,102
Trichloroethylene	767,587	649,953	607,212
Xylenes	5,642,573	5,877,684	5,840,523
Total for 17 chemicals	**30,827,766**	**27,117,257**	**25,032,024**
Total for all toxic chemicals	**120,284,333***	**112,393,518**	**78,808,069**
Percent of total for the 17 highly toxic chemicals	**25.6%**	**24.1%**	**31.8%**

**1988 total does not include aluminum oxide (non–fibrous) and sodium hydroxide solution (total of 40 million pounds) which were delisted for 1989 reporting.*

Note: Many of these chemicals are known or suspected carcinogens.

Source: Kentucky Department for Environmental Protection, Toxic Chemical Release Inventory Data,1988-90.

Nearly 32% of the 78.8 million pounds of toxic emissions/transfers reported in Kentucky during 1990 were highly toxic chemicals that the U.S. EPA has prioritized for reduction. In 1991, the U.S. EPA asked industries to voluntarily reduce these emissions because of the risks they pose to human health and the environment.

Figure 6

Top 3 Companies Releasing/Transferring Highly Toxic Chemicals in Kentucky in 1990

Chemical	Top 3 Companies with Releases/Transfers	County	Amount Released/Transferred (pounds) 1989	1990
Benzene	Armco Steel	Boyd	186,000	172,350
	Atochem Inc.	Marshall	2,800	162,800
	Ashland Oil	Boyd	156,867	124,040
Carbon tetrachloride	Atochem Inc.	Marshall	24,266	8,020
	Westlake Monomers	Marshall	NR	2,641
	Ashland Oil	Boyd	NR	2,140
Chloroform	Willamette	Hancock	221,100	161,500
	Westlake Monomers	Marshall	NR	26,910
	DuPont	Jefferson	NR	19,607
Cyanide compounds	Armco Steel	Boyd	29,250	29,000
	ATR Wire/Cable	Boyle	2,554	7,345
	Commonwealth Aluminum	Hancock	4,540	4,016
Dichloromethane (Methylene chloride)	E. R. Carpenter	Logan	625,500	676,150
	Gates Rubber	Hardin	170,000	175,000
	G. E. Appliances	Jefferson	214,900	173,989
Lead	SKW Alloys	Marshall	115,000	60,408
	Phillips Lighting	Boyle	154,414	33,209
	Johnson Controls	Jefferson	160,237	5,262
Lead Compounds	Englehard Corp.	Jefferson	NR	158,970
	Aristech Chemical	Boone	149,147	101,109
	American Standard	Johnson	89,334	91,748
Methyl Ethyl Ketone	Logan Aluminum	Logan	301,700	264,141
	Autostyle Plastics	Christian	84,255	259,164
	Ambrake	Hardin	83,294	132,366
Methyl Isobutyl Ketone	Hi–Tek Polymers	Jefferson	265,242	525,969
	Toyota Motor	Scott	341,832	208,800
	Air Products	Marshall	321,700	143,719
Tetrachloroethylene (perchloroethylene)	Premium Allied Tool	Daviess	NR	100,837
	Semicon Assoc.	Fayette	91,125	99,000
	Ken–Tron	Daviess	72,329	58,856
Toluene	American Synthetic Rubber	Jefferson	5,364,066	5,201,388
	Standard Gravure	Jefferson	1,400,250	1,003,250
	Hi–Tek Polymers	Jefferson	431,556	968,345
Trichloroethylene	Signet Systems	Mercer	106,492	194,671
	Holley Replacement Parts	Warren	145,663	164,680
	U.S. DOE–Paducah GD Plant	McCracken	90,550	68,392
Xylene (Mixed isomers)	GTE Products	Woodford	2,072,406	2,064,003
	Hi–Tek Polymers	Jefferson	172,730	663,854
	Akzo Coatings	Jefferson	203,122	590,111
1,1,1 trichloroethane (Methyl chloroform)	E. R. Carpenter	Logan	442,960	487,550
	G. E. Engines	Hopkins	118,915	163,000
	Briggs and Stratton	Calloway	170,390	162,743
Cadmium* compounds	Englehard Corp.	Jefferson	NR	48,955
	PMS Consolidated	Boone	NR	1,255
	Premier Polymers	Jefferson	1,250	760
Chromium	Ashland Oil	Boyd	32,170	15,157
	U.S. DOE Paducah GD Plant	McCracken	12,649	14,408
	Logan Aluminum	Logan	4.273	5,263
Chromium compounds	Armco Steel	Boyd	39,791	52,955
	Englehard Corp.	Jefferson	NR	33,378
	DuPont	Jefferson	9,960	10,260
Mercury**	B. F. Goodrich	Marshall	26,066	13,217
Nickel	Ashland Oil	Boyd	51,100	51,192
	ISP Chemicals	Marshall	NR	25,410
	G. E. Appliances	Jefferson	6,000	9,588
Nickel compounds	United Catalysts–West	Jefferson	21,559	76,648
	G. E. Appliances	Jefferson	11,100	41,149
	Porcelain Metals	Jefferson	NR	24,026

**Only 5 pounds of cadium were reported for 1990.*
*** Only one facility reported mercury releases/transfers.*
NR–none reported

Source: Kentucky Department for Environmental Protection, Toxic Chemical Release Inventory Data, 1990

Industries Emitting 17 Highly Toxic Chemicals Asked to Voluntarily Reduce Emissions; 34 Commit to Reductions

In January 1991, the U.S. EPA launched a program to encourage industries that release significant amounts of 17 highly toxic chemicals to voluntarily reduce their emissions. The "33/50 Program" sets a nationwide voluntary goal to reduce the total releases or transfers of these chemicals 33% by 1992 and 50% by 1995, using 1988 releases as the baseline.

The Kentucky Department for Environmental Protection contacted the top 25 toxic chemical emitters in 1989 and requested that they implement programs to reduce toxic emissions at their facilities. As of June 1991, the corporate headquarters of 34 industries with plants in Kentucky had committed to the 33/50 Program **(Fig. 7)**. Nine of these companies were among the state's top 25 toxic emitters during 1989.

An example of industrial efforts to reduce toxic emissions is the Westvaco Company, located in Wickliffe. The paper company joined the 33/50 Program, and has set a goal to reduce the total volume of toxic chemicals released 50% by 1992. Westvaco has initiated a variety of process changes which will enable them to meet or exceed their goal for hazardous waste and toxic emissions reductions. The company reports that releases of dioxin, a chemical on which the U.S. EPA has focused attention because of its toxicity, were reduced more than 96% by the end of 1989.

Other actions reported by Kentucky companies participating in the 33/50 Program include the following:

◆ Engelhard Corporation in Louisville recently completed a project to reduce fugitive dust emissions in the bagging area for lead and chromium compounds.
◆ Rockwell International Corporation in Louisville eliminated the use of a flush/cleanup solvent containing dichloromethane and is currently exploring alternative adhesive systems. Releases/transfers of dichloromethane were 32,096 in 1990 compared to 80,748 in 1989.
◆ Thomas Industries in Hopkinsville installed a new electroplating system to reduce all chemicals used in the electroplating and wastewater treatment areas and installed a more efficient, higher capacity electrostatic paint machine. Tetrachloroethylene emissions were reduced by using less toxic alkaline cleaners for electroplated parts.
◆ Ford Motor Company, at both the Truck and Assembly Plants in Louisville, reported that they have formed a waste minimization committee, funded research projects to investigate solidifying waste process sludges, and investigated technologies to incinerate combustible hazardous waste. Additionally, the phosphate system at the truck plant was modified to eliminate the use of chromium. In order to recover the maximum amount of usable paint, the company designed new paint storage tanks.

While these efforts are noteworthy, they appear to be more the exception than the rule. Only 44 of the 349 industries which release toxic chemicals reported emission reductions in response to a request for information by the Department for Environmental Protection in 1991.

Figure 7

Kentucky Companies Participating in the 33/50 Toxic Reduction Program

Parent Company	Kentucky Facility	Location
Air Products & Chemicals	Air Prod & Chem	Calvert City
Allied Signal	Allied Auto BHVS	Frankfort
American Synthetic Rubber	American Syn Rub	Louisivlle
Aristech Chem	Aristech Chem Corp	Florence
Armstrong World Industries	American Olean Tile Co	Lewisport
Ashland Oil	Ashland Petroleum Catlettsburg Refinery	Ashland
BASF	BASF Corp	Louisville
Borden	Borden Inc Pkg	Louisville
Cargill	North Star Steel KY	Calvert City
DuPont	DuPont Louisville	Louisville
Eaton	Eaton Corp	Bowling Green
	Eaton Corp	Henderson
	Eaton Corp	Glasgow
Engelhard	Harshaw Chem Co	Louisville
Ford Motor	Ford Motor Co KY	Louisville
	Ford Motor Co KY	Louisville
GAF	GAF Chem Corp	Calvert City
General Elec	GE Appliances	Louisville
	GE Co. Aircraft Engines	Owensboro
General Motors	GMC CPC Group	Bowling Green
	Bowling Green	Bowling Green
Lexmark (IBM)	Lexmark	Lexington
Illinois Tool Works	ITW INC Shakeproof	Russellville
INCO United States	INCO Alloys Intrntl Inc	Burnaugh
Mallinckrodt	Mallinckrodt Inc Science Products Div	Paris
Masco Industries	Gamco Products	Henderson
	Norris Trim	Nicholasville
Olin	Olin Corp	Brandenburg
Raytheon	Speed Queen Co	Madisonville
Reynolds Metals	Reynolds Metals Co	Louisville
Rhone–Poulenc	Hi–Tek Polyments Plant	Louisville
Rockwell International	Rockwell International	Louisville
Sherwin–Williams	Sherwin–Williams Co	Richmond
Tecumseh Products	Tecumseh Products Co	Somerset
Texas Instruments	Texas Instruments Inc	Versailles
Thomas Industries	Thomas Industries	Hopkinsville
Trinova	Aeroquin Sterling	Henderson
	Maysville Elec Co	Maysville
Union Camp	Union Camp Corp	Shelbyville
Westvaco	Westvaco Corp	Wickliffe
3M	3M Co	Cynthiana

Source: U.S. Environmental Protection Agency, 1991

As of June 1991, 34 corporate headquarters with Kentucky plants committed to voluntary reductions of toxic chemicals. Nine of these companies were among the state's top 25 toxic emitters in 1989. The 33/50 Program sets a nationwide goal to reduce releases 33% by 1992 and 50% by 1995.

Multi–Media Toxics Study Underway for Calvert City Area; Preliminary Results Indicate Elevated Levels of Air Toxics

Some communities, such as Louisville and Calvert City, receive a large burden of toxic chemical releases due to their proximity to industrial sources. Little is known about the influence of weather patterns, individual susceptibility, long–term exposure, and the cumulative effects of multiple toxic emissions on health and the environment. To better determine these interactions, a multi–media study is being conducted in Calvert City to assess health and environmental impacts from toxics released to the air and water.

Air toxics data have been collected in the Calvert City area for the past 18 months. Preliminary study results indicate that short–term elevated levels of various air toxics may be cause for concern. Monitoring will continue in an effort to better understand these events and the factors contributing to them.

A study of Cypress Creek, which flows through the Calvert City industrial complex, is now complete and results indicate no significant water quality problems. However, stormwater runoff is still being evaluated, in addition to the problem of ethylene dichloride (EDC) contamination present in the nearby Ohio River. EDC has been detected in Paducah's public water system, which provides additional treatment to remove the chemical. The source of this contaminant is believed to be the B. F. Goodrich/Airco Superfund site. The U.S. Geological Survey is currently developing a model for evaluating the quality of the region's groundwater resources. In addition, area soils will be sampled in 1992 and analyzed for metals and possibly soil gases.

The federal Agency for Toxic Substances and Disease Registry is in the process of designing a study to assess health problems in the Calvert City area. Because Kentucky does not have a cancer or birth defect registry, this study may involve a house–by–house canvass in the area to identify adverse health patterns. To date, about $2 million in federal and state funds have been spent on the Calvert City multi–media study. A majority of the study is expected to be complete by the end of 1992.

Risk Assessment

Risk assessment represents a relatively new approach to looking at environmental problems by evaluating the sources and types of contaminants and the routes and risks of exposure. The U.S. EPA is moving toward the use of risk assessments to develop environmental standards. In addition, the agency has used risk–based cleanups for all the national Superfund waste sites, including those in Kentucky which have had remediation.

The use of risk assessment has been criticized by some who assert that adequate information is not available to accurately determine the risks to human and ecological health from the thousands of chemicals currently or previously used. Some contend that the use of risk assessment raises moral issues as well, regarding increased risks to persons who would not be aware of the risk, or have input into determining what risks are acceptable.

Risk Assessments to Determine Cleanup Standards at 15 Waste Sites; Use Expected to Increase in Kentucky

The use of risk assessments to determine whether a cleanup is necessary and how extensive it should be is provided under federal law. However, Kentucky has generally relied on the two other federal remediation options: (1) cleanups to background levels, and (2) corrective measures which allow the closure of waste in place.

Background level cleanups are based on the amount of a particular contaminant that would normally be found in the area before any wastes or toxic substances were disposed or accidently released. The use of background standards has been a concern at some cleanups where responsible parties claim that these levels are too costly to attain in relation to the risks posed. Others counter that allowing contamination to remain, shifts the cost of pollution to the public in the long–term by degrading resources. Corrective measures involve the closure of a site using methods such as soil caps, groundwater restoration, and cut–off walls.

The use of risk assessments in determining acceptable cleanup levels for contaminated sites was adopted into state statute in 1990. The risk assessment program, within the Kentucky Division of Environmental Services, has since completed reviews of proposed risk–based cleanups at 19 contaminated sites and more than 40 reviews are underway. Two have been approved, but most have not because data submitted to the state were inadequate. Once a risk assessment is complete the state must determine what cleanup level is acceptable given the likelihood of public exposure, environmental impacts, and the cost to clean up the site. This “risk management” decision making process is currently ongoing for the 19 risk assessments which have been completed to date.

Most risk assessments have been conducted for natural gas pipeline transmission stations. PCB contamination has been discovered at 24 of the 61 pumping stations in Kentucky. Because there is no “background” level for PCBs, the state has used risk assessments to confirm that the previously used cleanup level of one part per million in soils is sufficient to protect the public from an increased cancer risk.

A risk–based cleanup has also been considered for the site of a proposed low income housing development project in Louisville. Lead levels in the surrounding soils were discovered to be high enough to cause harmful effects in exposed persons, especially children who are more susceptible to lead poisoning. Background lead levels throughout Louisville are elevated as a result of industrial emissions and the use of lead–based fuels and paints. The housing project has been stalled until the city, which is concerned about the high cost of removing the contaminated soil, makes a determination on whether to clean up the site.

Most lending institutions now require site assessments prior to the approval of loans for development activities. The bank involved in this particular housing project has indicated it will not approve the project’s loan until the state and city agree to a cleanup plan that will reduce soil contamination below the level of concern. Risk assessments have also been conducted for leaking underground storage tank sites and some abandoned hazardous waste sites in Kentucky.

The use of risk assessments to determine cleanup levels will likely increase, as will the debate regarding state toxic cleanup standards. The determination of "how clean is clean" will continue to be argued from economic, scientific, and moral viewpoints at both the state and national levels.

Toxics in the Home

The average person can also be exposed to toxic chemicals around the home, in schools, and in the workplace. Many commonly used products such as pesticides, cleaners, paints, solvents, and gasoline contain toxic chemicals that are highly volatile. These chemicals can be absorbed through the skin or inhaled. While data are not available to assess the risks posed by most of these products, some can cause adverse health affects. Interest in less toxic and non–toxic products appears to be increasing. Many retailers are now stocking these products to meet the new demand.

Lead–Based Paint in Homes Receives Greater Attention; Children Especially at Risk

One well–known example of exposure to toxics in the home is lead–based paint. Paint manufactured before 1977 is considered the main source of lead in homes. Children are particularly susceptible to lead poisoning which can cause brain damage, mental retardation, and muscle weakness. According to the federal government, about two million children live in homes with lead–based paint. The U.S. Public Health Service estimates that one in six children tested for lead exposure have blood levels high enough to cause mental and behavioral problems. Lead can also be absorbed from drinking water and lead–based gasoline fumes.

The Lexington/Fayette County Health Department is beginning a program to prevent lead poisoning in children. The Childhood Lead Poisoning Prevention Program will begin free testing for children up to six years old, and will target homes that are suspected to contain lead–based paint. The federal government is expected to recommend that all children be tested for lead exposure by the age of two, and that action be taken to help those with elevated lead levels in their blood.◆

Picture of warning sign

Chapter 5
Natural Resources

Natural Resources

Kentucky is rich in natural resources. Farmland, forests, wetlands, caves, and natural streams, together with wildlife resources, help to form the state's economic base and contribute to Kentucky's high quality of life.

The treatment of these resources has shifted over the last decade from exploitation to policies promoting their management and conservation and, in some cases, preservation. A growing U.S. and world population and expanding state, national, and global markets will place ever–increasing demands on Kentucky's natural resources. The state's progress in balancing these demands with the management and conservation of its land and natural resources is the focus of this chapter. The topics reviewed are: Land Management, Agricultural Lands, Forestry, Natural Areas, Fish and Wildlife Resources, and Threatened and Endangered Species.

Picture of waterfall

Land Management

Kentucky's land is one of its most valuable resources. The many uses of land, some of which are incompatible, continue to place increasing pressures on this resource.

This section reviews land use changes and state and local efforts to manage land resources through sound stewardship and wise use.

Majority of Land in Kentucky Covered by Forest and Farmland

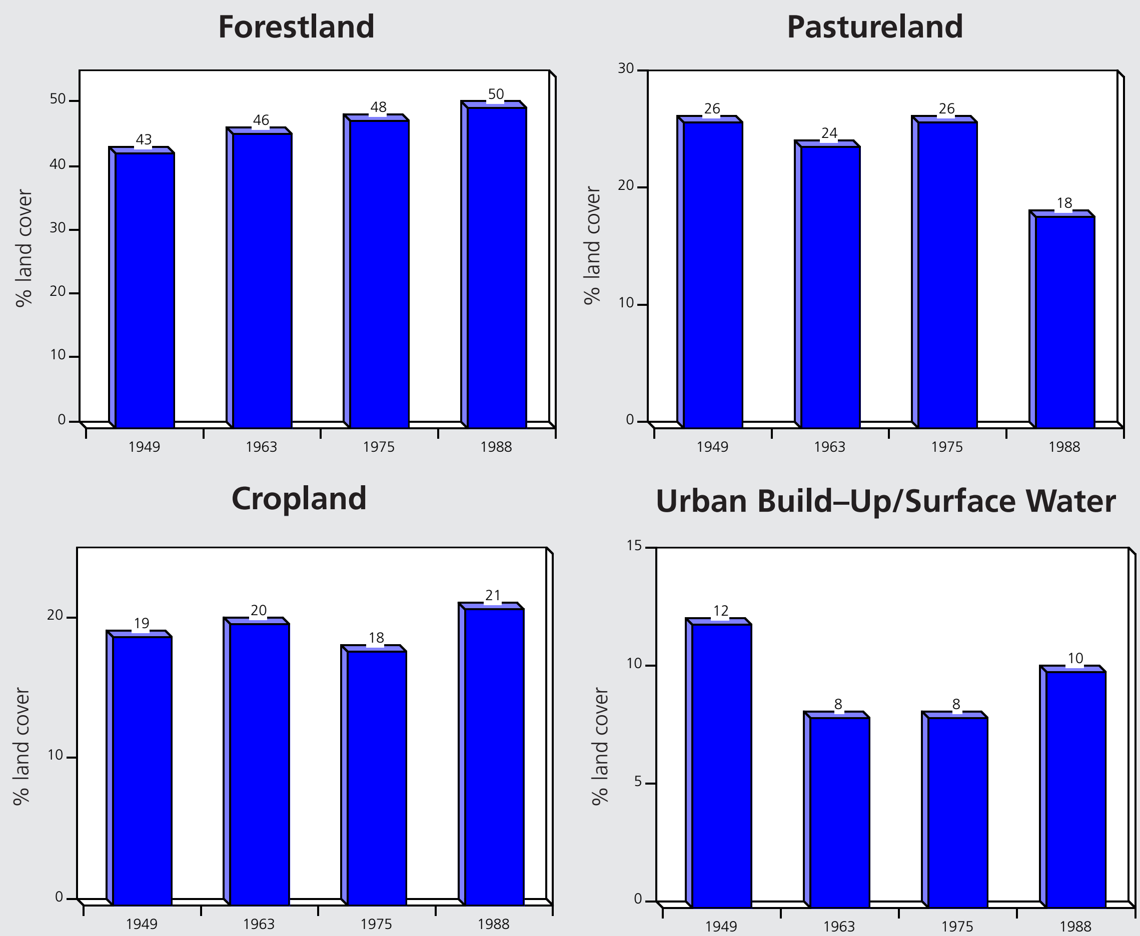
The present composition of the 25.8 million acres of land in Kentucky is forests (49%), cropland (21%), and pastureland (18%). The remaining 12% is in urban build–up, transportation routes, and surface water. Land use patterns in Kentucky have changed over time with forests and cropland increasing and pastureland decreasing since 1949, according to U.S. Forest Service surveys. **(Fig. 1)**.

The U.S. Soil Conservation Service also conducts surveys and estimated in 1987, that forests comprised 40% of the state's land area, followed by pastureland at 23%, and cropland at 22%. Which of these two estimates more accurately reflects the land use patterns in Kentucky is difficult to determine, although the U.S. Forest Service survey reports provide a consistent view of land use changes since the 1940s.

The changing uses of land reflect shifts back and forth among the different categories. For example, old farms have reverted to forests, surface mines which have disturbed thousands of acres of forest and farmland have been reclaimed to various uses, and some pastureland has been converted to cropland. Some changes, however, are permanent such as urban build–up, roads, and the loss of land from stream and river impoundments. Urban build–up accounts for about 9% of the land area and water covers approximately 2% of the state's acreage. While these conversions are not taking place today at the rates experienced in earlier years, continuing demand for urban development, water and flood control structures, and other uses will continue to permanently alter land in Kentucky.

Picture of development along River

Figure 1
Changes in Land Uses in Kentucky



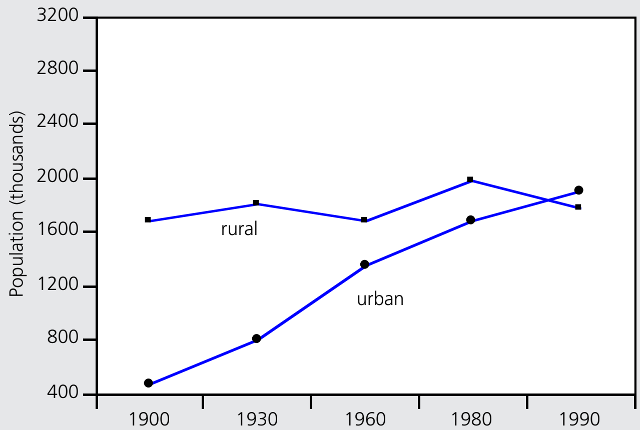
Note: 1988 data most recent available.
Source: U.S. Census of Agriculture, U.S. Department of Commerce, U.S. Forest Service Surveys, 1953-1988

Land use patterns reflect changes among various categories. Some changes, however, are permanent. For example, urban build-up represented 9% of the land area in Kentucky during 1988.

Land Use Planning Commissions in Fifty–three Counties, Sixty–one Cities

With the population of Kentucky shifting from rural to urban settings, land use conflicts are steadily increasing, particularly in urban fringe areas **(Fig. 2)**. Several communities have become increasingly aware of the impacts of economic and residential growth on their local cultural and historic values, as well as on environmental and natural resources. County and city planning and zoning are widely viewed as a method to better balance growth with social and environmental factors. According to a 1987 survey conducted by the Kentucky Legislative Research Commission, 53 of the state's 120 counties have established planning commissions, of which 49 are city/county commissions and four are independent county commissions. In addition, 61 cities have established independent city planning commissions, although four of these commissions reported they were currently inactive **(Fig. 3)**.

Figure 2
Kentucky Population Trends



Source: Statistical History of the U.S. Almanac of the 50 States, Kentucky State Data Center, 1991

With Kentucky's population shifting from rural to urban settings, land use conflicts are steadily increasing, particularly in urban fringe areas.

Most of the counties and cities with planning commissions have developed comprehensive plans and zoning ordinances to provide for growth in a balanced manner. A 1991 survey conducted by the Kentucky Chapter of the American Planning Association revealed, however, that of the 20 counties with comprehensive plans responding, only 11 had updated their plans within the required five–year time frame.

Public resistance to government involvement in specifying land uses is a major obstacle to the adoption of city and countywide planning and zoning in Kentucky. For example, recent efforts to pass a planning ordinance in Montgomery County were unsuccessful due to public opposition. It is unlikely that comprehensive planning and zoning will play a significant role in many rural Kentucky communities. Instead, specific ordinances will continue to be the only method available to address land use issues at the local level for many communities.

State Considers Conflict Resolution Mechanism to Help Resolve Landfill Siting Disputes

Conflicts involving incompatible uses of land have been an increasing concern in Kentucky. In the past, the siting of some landfills, industries, roads, and other development projects, without full consideration of environmental and social factors has impacted land, air, water, cultural, and wildlife resources. A proposal to require the review of environmental and natural resources when siting state–funded development projects to minimize impacts was introduced in the 1990 Kentucky General Assembly, but failed to pass.

In some development projects, conflicts are unavoidable. The siting of landfills, for example, will likely be opposed by some local residents. A growing number of lawsuits have been filed in recent years by citizens and public interest groups challenging development projects because of their environmental impacts. In response, the use of SLAPP suits—Strategic Lawsuit Against Public Participation—has been increasingly used in Kentucky, most often by developers against environmentalists.

In an effort to resolve the potential conflicts associated with siting new solid waste landfills in Kentucky, the state enacted a law in 1991 to establish a mechanism to assist in resolving local and regional solid waste landfill siting disputes. Regulations were proposed in late 1991, however, they have not been implemented. The use of conflict resolution to address environmental disputes may prove extremely beneficial. For example, the current dispute resolution effort among environmentalists, industry, and sports groups to seek solutions involving the discharge of wastewater into Lake Cumberland will not only assist parties better understand each other's concerns, but also set the stage for cooperatively solving the conflict.

Another approach, established by citizens in seven counties of the Bluegrass Region, seeks to ensure that growth and economic development are accommodated without harming the area's unique natural, cultural, historic, and scenic resources. The mission of Bluegrass Tomorrow, a nonprofit community organization, is to focus on resource planning and management through research, community consensus building, and leadership, as well as to promote a management partnership between the public and private sectors.

Other activities of Bluegrass Tomorrow include:

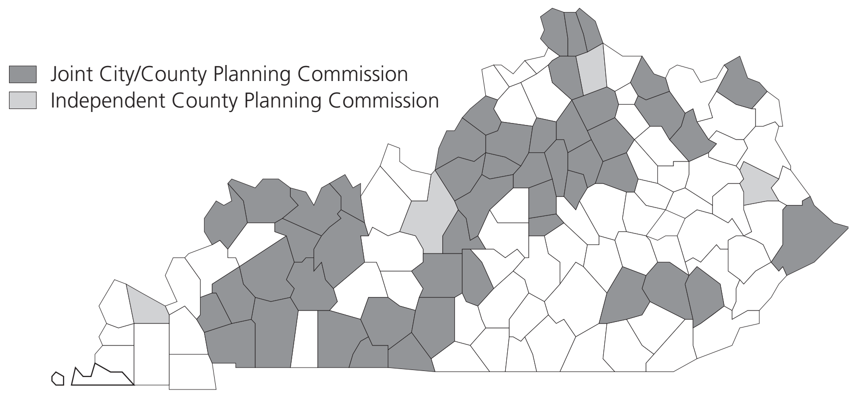
- ◆ Roundtable discussions bringing elected officials together to discuss issues,
- ◆ Issues identification and assessment, and
- ◆ Farmland conservation workshops.

The organization has served as a facilitator in several land use conflicts in the region. This initiative can serve as both a county and regional model for use throughout Kentucky.◆

County and city planning is viewed as a method to better balance growth with social and environmental factors. Fifty–three of Kentucky's 120 counties have established county or joint city/ county planning commissions. Sixty–one cities have enacted their own independent planning commissions.

Figure 3

County and Joint City/County Planning Commissions



Independent City Planning Commissions

City	County	City	County
Columbia	Adair	Flatwoods	Greenup
Owingsville	Bath	Elizabethtown	Hardin
Middlesboro	Bell	Radcliff	Hardin
Pineville	Bell	Vine Grove	Hardin
Ashland	Boyd	Nicholasville	Jessamine
Catlettsburg	Boyd	Paintsville	Johnson
Jackson	Breathitt	Barbourville	Knox
Cloverport	Breckinridge	Whitesburg	Letcher
Hardinsburg	Breckinridge	Stanford	Lincoln
Irvington	Breckinridge	Lebanon	Marion
Morgantown	Butler	Brandenburg	Meade
Alexandria	Campbell	Muldraugh	Meade
Bellevue	Campbell	Mt. Sterling	Montgomery
Cold Spring	Campbell	Carlisle	Nicholas
Dayton	Campbell	Owenton	Owen
Ft. Thomas	Campbell	Hazard	Perry
Highland Heights	Campbell	Stanton	Powell
Newport	Campbell	Burnside	Pulaski
Wilder	Campbell	Somerset	Pulaski
Carrollton	Carroll	Russell Springs	Russell
Liberty	Casey	Campbellsville	Taylor
Burkesville	Cumberland	Elkton	Todd
Prestonsburg	Floyd	Springfield	Washington
Warsaw	Gallatin	Providence	Webster
Lancaster	Garrard	Corbin	Whitley
		Williamsburg	Whitley

Source: Kentucky Legislative Research Commission, 1987

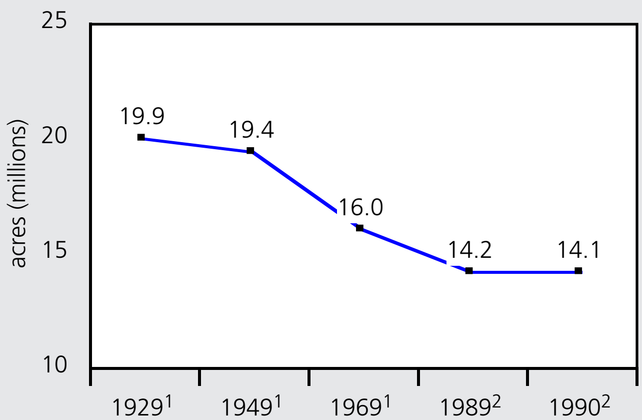
Agricultural Lands

Kentucky's agricultural land base produces a tremendous variety of commodities as well as economic benefits for the state. In 1990, for example, farm products generated cash receipts of $3.1 billion.

Farms currently cover an estimated 50 to 55% of the land area in Kentucky **(Fig 4)**. Despite a 29% decrease in farm acreage since 1929, the state still ranks fourth in the nation for the number of farms. Generally, Western Kentucky is intensively cropped for grains, while the Central and Eastern regions of the state support a more diverse array of agricultural commodities including livestock, grain, and tobacco.

This section reviews the role of agriculture in Kentucky's economy. Efforts to preserve prime farmland and promote conservation and management are also assessed.

Figure 4
Total Farmland in Kentucky



Source: [1]U.S. Census of Agriculture, 1991
[2]Kentucky Agricultural Statistics Service, 1991

Despite a 29% decrease in farmland acreage since 1929, farms still cover half of Kentucky's land area.

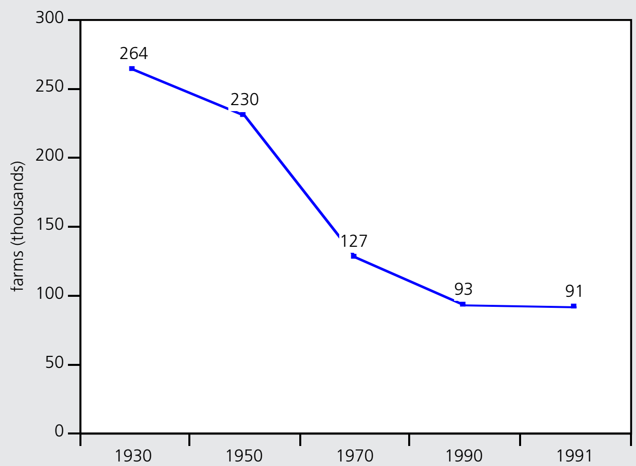
Kentucky's Changing Agriculture Base

Kentucky farmlands have undergone changes over time, reflecting economic and social conditions and technological advances. General observations regarding the state's agricultural land base include the following:

- **Number of Farms Continue to Decline**
  As farming has become more specialized and food more commercially available, the number of small general farms has declined in Kentucky. In 1930, 264,000 farms were in production throughout the state. By 1970, the number of farms in the state decreased to 127,000. Kentucky now has an estimated 91,000 farms **(Fig. 5)**.
- **Majority of Farms Produce Tobacco, Hay, and Beef Cattle**
  According to the 1987 U.S. Census of Agriculture, 67% of the state's farms produce tobacco and 55% produce hay. Kentucky farms also produce beef cattle (33%), corn (26%), horses (15%), soybeans (9%), pigs (8%), poultry (7%), wheat (6%), and other crops and livestock (8%) **(Fig. 6)**.

Figure 5

Number of Farms in Kentucky

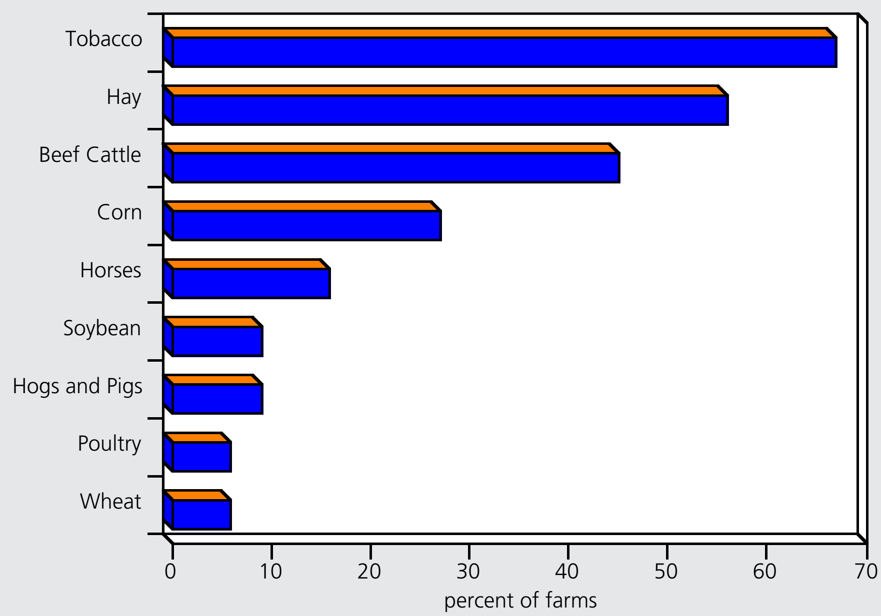


Source: Kentucky Agricultural Statistics Service, 1991

The number of farms has steadily declined over the years. Kentucky currently has an estimated 91,000 farms in operation, ranking the state fourth in the nation for the number of farms.

Figure 6

Kentucky Farms and Major Commodities Produced



Source: U.S. Census of Agriculture, 1987

Sixty–seven percent of the state's farms produce tobacco and 55% produce hay. Other products include beef cattle, corn, and horses.

- **Small Farms Decline in Number, While Larger Farms Increase**
  The move to larger production farms in Kentucky has become increasingly more evident. Between 1929 and 1987, ten to 49–acre farms decreased 76% while 1,000 to 2,000–acre farms increased 251% **(Fig. 7)**. The average–size farm in Kentucky has increased to 155 acres **(Fig. 8)**. Family farms are decreasing in Kentucky as well. In 1982, 85,800 farms were family owned. In 1990, about 78,500 farms were family owned.
- **51% of Farms Are in Bluegrass and Central Regions**
  The number of farms in Kentucky's 120 counties varies from a high of 2,266 in Pulaski County, to a low of 25 in Martin County. Most farms are located in the Bluegrass and Central regions of the state **(Fig. 9)**. The greatest change in the number of farms and their acreage occurred in Eastern Kentucky. During the past 30 years, farm acreage in this region decreased from 3.5 million acres to 2 million, a 42% reduction.

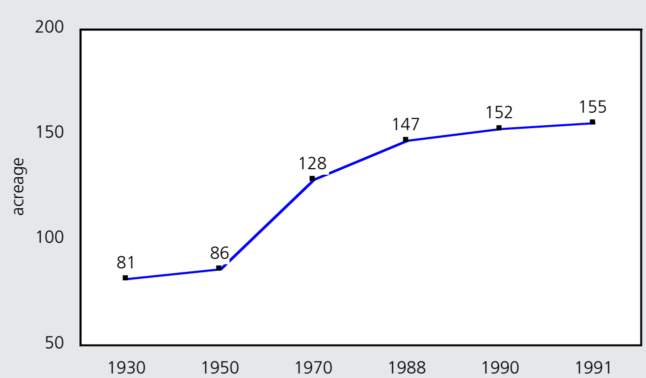
The move to larger production farms in Kentucky has become more evident over time. The number of family farms in the state continues to decline.

Figure 7
Changes in Farm Sizes in Kentucky

Acres	1–9	10–49	50–174	175–499	500–999	1000–1999	2000+
1929	21,368	85,999	115,118	22,307	1,407	300	n/a
1949	24,173	66,567	102,382	22,776	1,933	406	n/a
1969	13,914	26,761	58,425	22,083	3,142	630	114
1987	10,648	20,707	38,261	17,920	3,618	1052	247
% change 1929–1987	**-50%**	**-76%**	**-66%**	**-20%**	**157%**	**251%**	**117%**

n/a—not available
Source: U.S. Census of Agriculture, 1987

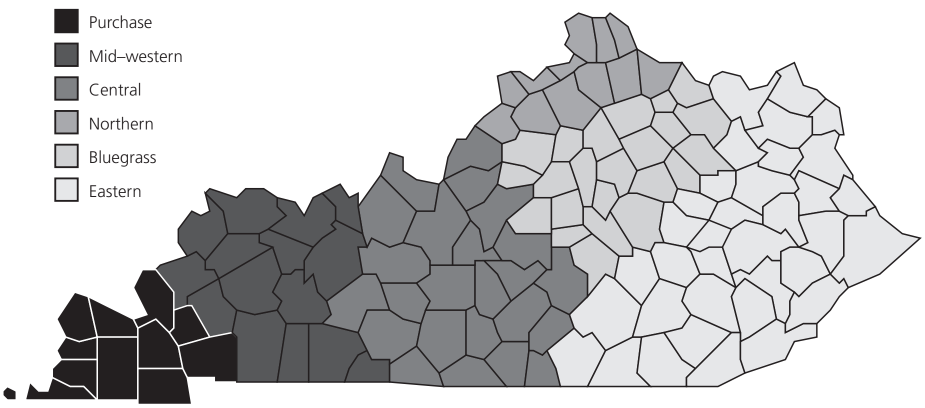
Figure 8
Size of the Average Farm in Kentucky



Source: Kentucky Agricultural Statistics, 1991

The average-size farm in Kentucky continues to increase and is now 48% larger than was the case in 1930.

Figure 9
Distribution of Farms in Kentucky



Region	Number of Counties	Number of Farms 1959	Number of Farms 1990	Land in Farms (million acres) 1960	Land in Farms (million acres) 1990	% of Total Land Area in Farms 1990
Purchase	11	12,267	5,350	1.5	1.1	53.7
Mid–western	15	19,206	11,018	2.8	2.6	64.0
Central	24	40,194	28,589	4.4	3.8	66.0
Northern	12	11,416	8,461	1.4	1.2	72.2
Bluegrass	23	29,316	22,596	3.4	3.4	89.4
Eastern	35	38,585	16,439	3.5	2.0	24.3
Statewide	**120**	**150,984**	**92,453**	**17.0**	**14.0**	**55.2**

Source: Kentucky Agricultural Statistics, 1960, 1990

The distribution of farms has undergone change over the years. The greatest change has been a 42% reduction of farmland in Eastern Kentucky during the last three decades.

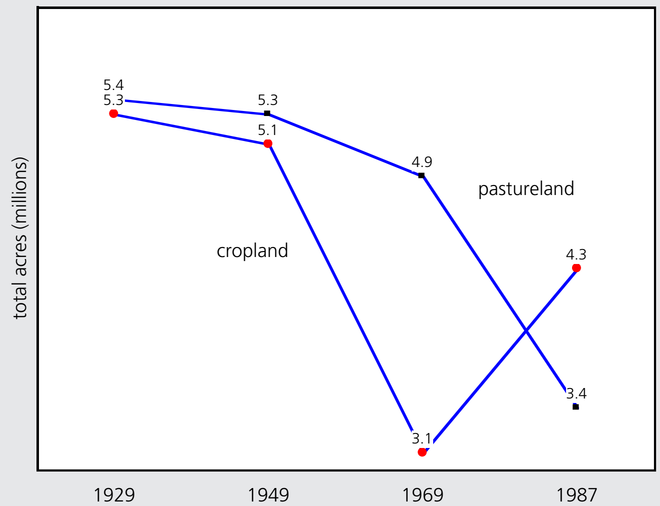
Agricultural Products

Crop Production Increases; Tobacco and Hay Lead in Value

The amount of land actively used in Kentucky for crop and pasture has decreased steadily during the last 60 years **(Fig. 10)**. However, agricultural production levels and commodity values continue to increase. More intensive farming and better marketing have helped to make agriculture one of the leading industries in the state, as well as in the nation.

Kentucky ranks first in the nation for the production of burley tobacco, and second to North Carolina for all tobacco produced. In addition, the state ranks eleventh in the nation for hay, fourteenth for soybean production, and twentieth for winter wheat.

Figure 10
Crop and Pastureland in Use in Kentucky



Note: 1987 data most recent available.

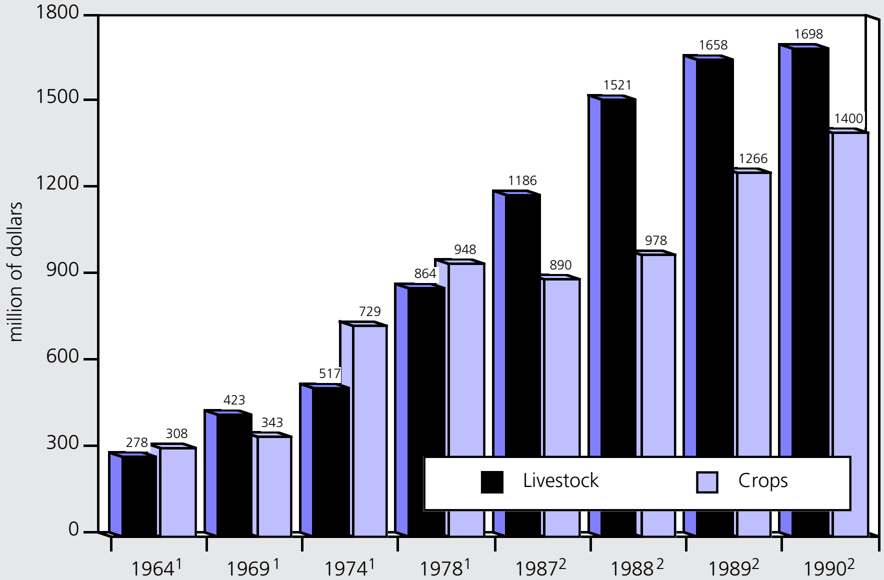
Source: U.S. Census of Agriculture, 1987

Crop and pastureland acreage has steadily decreased in Kentucky. Agricultural land used for crops, however, has been increasing since 1969 and surpassed pastureland acreage in 1987.

Some general facts and trends pertaining to the production of crops in Kentucky include the following:

- **Cash Receipts from Crops Continue to Increase**
  In 1990, the total value of crops produced by Kentucky farmers was $1.4 billion. This was more than four times the crop value realized in 1964, without factoring in inflation **(Fig. 11)**. Export markets have contributed to the increase in production and revenue generated from crops produced in Kentucky. In 1990, the state exported $658 million worth of tobacco, feed grains, soybeans, wheat, dairy products, seeds, and other products. This was a 23% increase since 1988 when crop exports were valued at $505 million.
- **Technologies, Chemicals, and New Products Produce Greater Crop Yields per Acre**
  New technologies and products, particularly pesticides, fertilizers, and new and improved seed varieties, have increased crop yields and production levels of Kentucky's cash crops.
- **Tobacco Number One Cash Crop in Kentucky**
  Tobacco was the number one cash crop in Kentucky representing 45% of the total statewide crop value during 1990, compared to 37% in 1989. In 1982, tobacco production reached record levels in the state, but generally declined until 1990 when production began to rebound. Yield per acre of tobacco decreased 16% between 1970 and 1990, largely due to changes in federal farm programs **(Fig. 12)**.
- **Hay Production at an All–Time High**
  Hay is the second most valuable crop in Kentucky. The amount of hay produced in 1990 was at an all–time high with a value of $351.5 million. Yield per acre of hay,

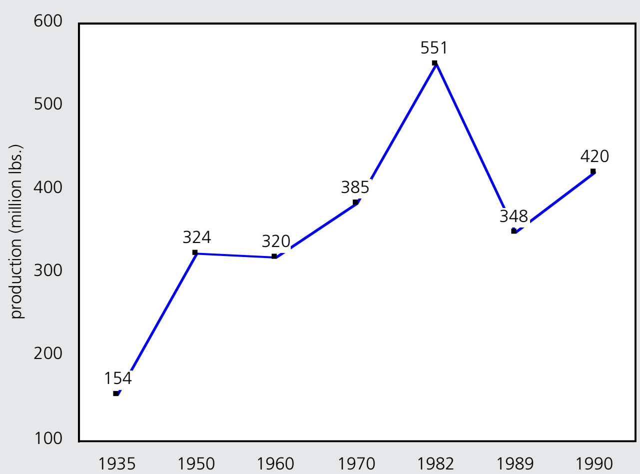
Figure 11
Kentucky Cash Receipts from Crop and Livestock Products



Source: [1]U. S. Census of Agriculture, 1987
[2]Kentucky Agricultural Statistics, 1991

While land actively used for crops and livestock has decreased in Kentucky, production levels and cash receipts continue to increase. The development of export markets for Kentucky farm products has contributed to the increase. In 1990, Kentucky exported $658 million of agricultural goods, an increase of 23% since 1988.

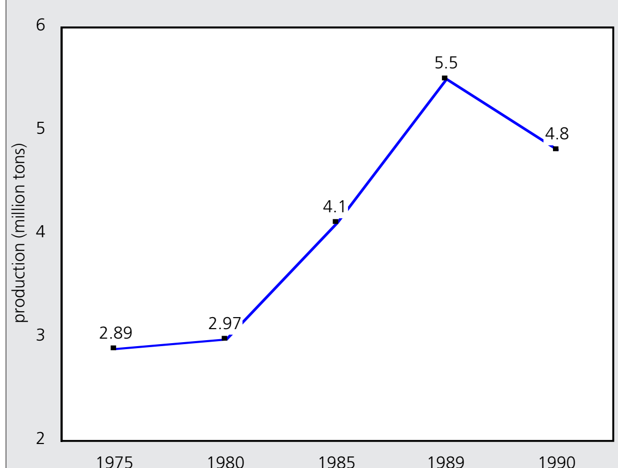
Figure 12
Kentucky Burley Tobacco



Average yield per acre (lbs.)			
1935	765	**1988**	2,450
1950	1,165	**1989**	2,060
1960	1,625	**1990**	2,270
1970	2,710		

Source: Kentucky Agricultural Statistics, 1991

Figure 13
Kentucky Hay and Alfalfa

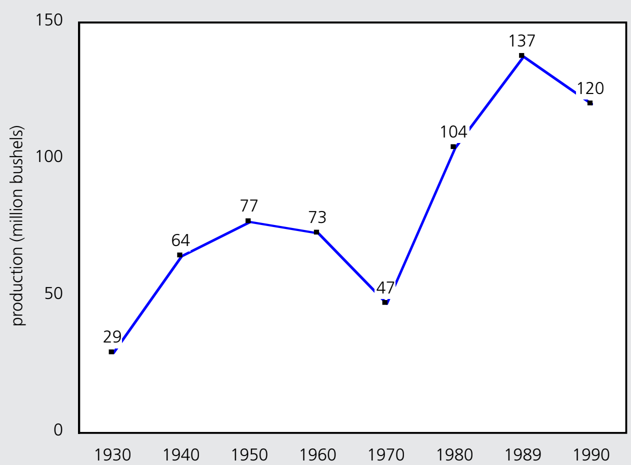


Average yield per acre (tons)	1975	1980	1985	1989	1990
Alfalfa	2.90	2.95	3.60	3.70	3.40
All other hay	1.75	1.75	2.00	2.10	2.00

Source: Kentucky Agricultural Statistics, 1991 however, has declined from 2.9 tons/acre in 1975 to 2.2 tons/acre in 1990 **(Fig. 13)**.

- **Corn Yields More Than Double in 30 Years**
  Corn is third in value representing 21% of the state's total crop value. Corn yields per acre show greater increases than any other crop. Corn yields nearly doubled between 1960 and 1989, from 48 bushels per acre to 100 bushels per acre. Production levels reached record levels in 1989 at 137 million bushels, then declined to 120 million bushels in 1990 **(Fig. 14)**.
- **Soybean and Winter Wheat Production and Yields Increase Significantly**
  Soybean production increased from 7 million bushels to 39 million bushels, between 1965 and 1990. Yields rose from 23 bushels to 32 bushels per acre **(Fig 15)**.
  In 1970, about 5.7 million bushels of winter wheat were produced on 159,000 acres of farmland. Winter wheat production increased in 1990 to near record levels when 20 million bushels were harvested from 500,000 acres of farmland. Yields per acre increased 28% between 1970 and 1990, from 36 bushels/acre to 40 bushels/acre

Figure 14
Kentucky Corn

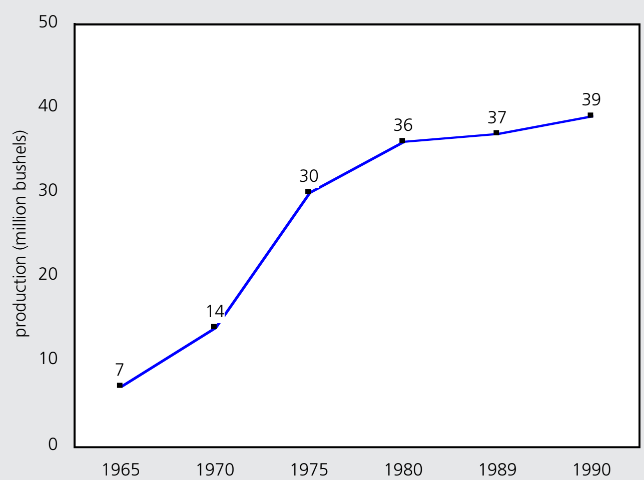


Average yield per acre (bushels)

1930	10	**1970**	50
1940	25	**1980**	70
1950	37	**1989**	116
1960	48	**1990**	100

Source: Kentucky Agricultural Statistics, 1991

Figure 15
Kentucky Soybeans

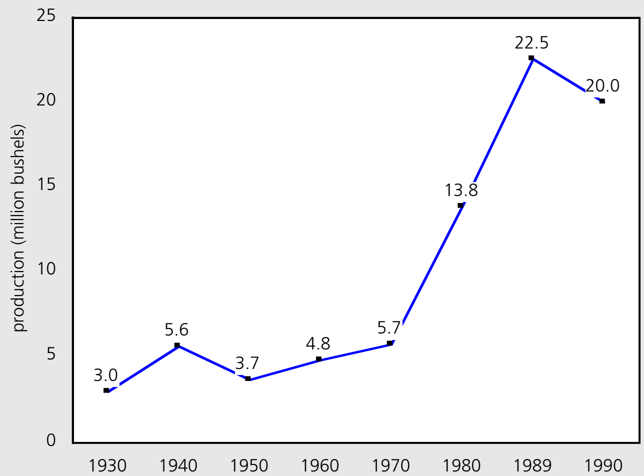


Average yield per acre (bushels)

1965	24	**1980**	23
1970	27	**1989**	32
1975	27	**1990**	32

Source: Kentucky Agricultural Statistics, 1991

Figure 16
Kentucky Winter Wheat



Average yield per acre (bushels)

1930	14	**1970**	36
1940	15	**1980**	40
1950	15	**1989**	50
1960	29	**1990**	40

Source: Kentucky Agricultural Statistics, 1991

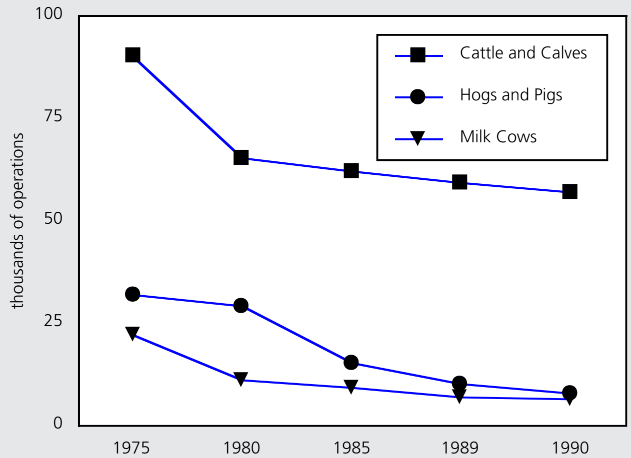
(Fig. 16).

Number and Acreage of Livestock Farms Decrease, But Revenues Reach Record High

Cash receipts from livestock have increased in Kentucky during the past two decades, although the increases have not been as dramatic in recent years. During 1990, cash receipts for livestock reached a record state high of $1.69 billion. Figure 11 shows the steady rise in value realized from livestock production. Kentucky currently ranks ninth in the nation for the production of beef cattle, twelfth for dairy cows, and fourteenth for hogs and pigs.

While livestock cash receipts continue to increase, the acreage of Kentucky pastureland is decreasing and with it the number of livestock farms. The number of livestock operations in the state began to decline during the 1970s and has continued through the 1980s and

Figure 17
Livestock Farms



Source: Kentucky Agricultural Statistics, 1991

The number of livestock operations began to decline in Kentucky during the 1970s. However, state livestock cash receipts were at a record high of $1.69 billion in 1990.

1990s **(Fig. 17)**. Some livestock production trends include the following:

- **Cattle and Calve Operations Decrease**
  The number of calve and cattle operations in Kentucky decreased 37% between 1975 and 1990, from 90,000 operations to 57,000. The statewide population of cattle and calve peaked at 3.75 million head in 1975. Populations have since declined and numbered 2.42 million in 1990.
- **Number of Dairy Cow and Pig Farms Decline the Most**
  The number of dairy farms declined significantly between 1975 and 1990, from 22,000 operations to 6,500. Hog and pig operations were reduced 77%, from 32,000 farms in 1975 to 7,500 in 1990. The state's hog and pig population fell from 1.68 million head in 1970 to 970,000 in 1990. Poultry farms experienced a decline in number as well.
- **Average Number of Dairy Cows per Farm Increasing**
  While the number of pig and dairy farms have decreased in Kentucky, the number of hogs and dairy cows per farm has increased. The average hog and pig population per farm was 43 in 1969 compared to 102 in 1987, according to U.S. Census of Agriculture data. Dairy cows increased from 11 per farm in 1969 to 32 in 1987. However, the beef cattle population fell from 32 in 1969 to 23 per farm in 1987. These trends reflect economic conditions as well as the move toward larger production farming in Ken-

tucky.

Prime Farmland

The loss of prime farmland is a continuing concern in Kentucky. Prime acres are the best lands for farming because they are flat, or gently rolling, and susceptible to little or no soil erosion. They are Kentucky's most energy–efficient acreage, producing the most food, feed, fiber, and forage with the least amount of fuel, fertilizer, and labor.

Prime Farmland Continues to be Converted; Agricultural District Act Assists in Protecting 167,412 Acres of Farmland

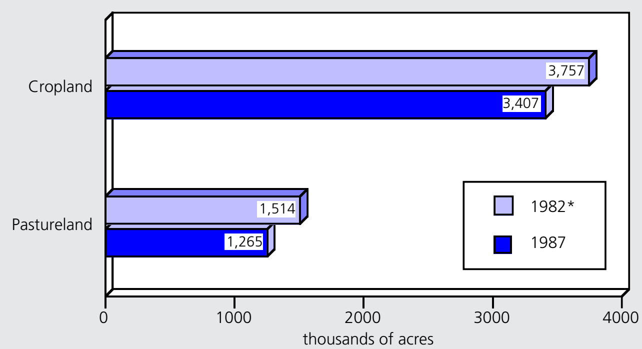
Most prime farmland in Kentucky is located in the Jackson Purchase and Bluegrass regions. Approximately 7% occurs in Eastern Kentucky. Prime cropland continues to be converted to other uses. In 1987, the U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS) designated 3.7 million of the state's 5.8 million acres of cropland as prime. This represented a loss of 350,000 prime cropland acres since 1982. Prime pastureland is being converted to other uses as well. In 1987, SCS designated 1.2 million acres of pastureland in Kentucky as prime. This represented a loss of 249,000 prime pastureland acres since 1982 **(Fig. 18)**. Since 1982, 1,492 acres of prime farmland have also been disturbed by coal mining in Kentucky. Prime farmland must be restored to its original condition after mining is completed.

In an effort to protect farmland, the state enacted the Agricultural District Act in 1982. Since then, 42 counties have formed 159 agricultural districts with 167,417 acres of farmland currently enrolled **(Fig. 19)**. The advantages of participating in the districts include lower property value assessments which reduce taxes, and protection from annexation when cities expand into rural areas. Any state–funded activities which result in the conversion of farmland in a certified agricultural district to non–farm use must be mitigated. Mitigation activities may require efforts such as minimizing the impacts of transportation projects that cut across farm property and relocating affected farm operations. However, the term "mitigation" has not yet been legally defined, so such efforts to reduce impacts have not proceeded.

In addition to agricultural districts, conservation districts play an important role in promoting sustainable farming. Conservation districts are a subdivision of state government and are generally organized according to county boundaries. The districts support and develop projects which promote conservation and often include water quality and quantity management, reforestation, and wildlife protection, in addition to conservation of agricultural lands. Each of the state's 121 conservation districts elect seven volunteer supervisors who provide leadership in farmland conservation practices.

The Interagency Farmland Task Force was established by statute in 1984 to advise the governor on state activities that contribute to the conversion of farmland to nonfarm uses. The task force is required to review state–funded projects that would result in a conversion of greater than 50 acres of farmland. The group has reviewed 52 projects involving 21,000 acres. This amount is reported to be significantly less than the acreage which has actually been converted because many Kentucky Transportation Cabinet projects are exempt from review. The task force has not met recently, although it is still reported to be functioning.

Figure 18
Status of Prime Farm Land in Kentucky



Note: 1987 data most recent available.

Source: USDA, Soil Conservation Service, National Resources Inventory, 1982–1987

Prime farmland, Kentucky's most valuable and best land for agriculture, continues to be converted to other uses. Between 1982 and 1987, 350,000 acres of prime cropland and 249,000 acres of prime pastureland were converted to other uses.

To protect prime and other farmland, the state passed the Agricultural District Act in 1982. Since then, 42 counties have formed 159 districts. Participating farms are protected from annexation and are assessed lower property taxes.

Figure 19
Kentucky Agricultural Districts

County	No. of Certified Districts	No. Acres
Anderson	1	675
Barren	11	5,017
Boone	8	4,646
Boyle	10	7,678
Bracken	3	5,271
Breckinridge	3	1,593
Bullitt	8	3,913
Calloway	5	3,638
Campbell	9	7,871
Carlisle	3	2,218
Christian	2	19,841
Clinton	2	1,228
Cumberland	2	3,281
Daviess	1	442
Franklin	9	11,027
Fulton	1	2,077
Grant	4	2,542
Grayson	1	342
Hardin	4	5,430
Henderson	7	10,582
Henry	1	2,186
Hickman	1	9,767
Jefferson	4	1,977
Kenton	4	4,090
Knox	2	1,599
Larue	6	5,141
Lewis	1	892
Lincoln	1	369
Logan	1	533
Marion	1	268
Martin	1	296
Mason	5	4,517
Nelson	9	4,625
Oldham	2	2,308
Russell	4	3,019
Scott	5	2,474
Shelby	4	10,461
Taylor	2	1,285
Todd	2	1,113
Wayne	1	2,679
Whitley	5	3,448
Woodford	3	10,240
Total 42	**159**	**167,417**

Note: Acreage was rounded.

Source: Kentucky Soil and Water Conservation Commission, 1991

Farmland Conservation and Management

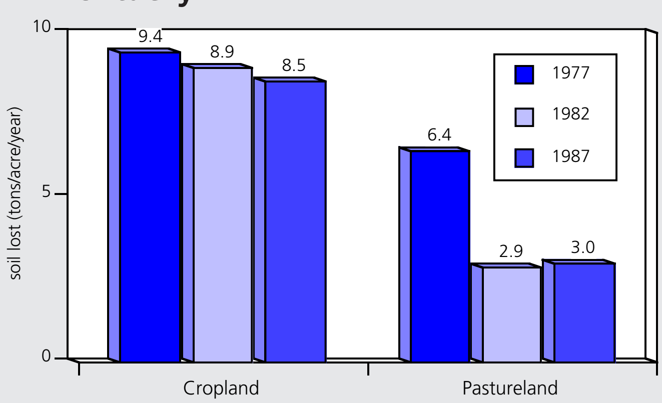
State and federal efforts to protect the quality of Kentucky's farmland, while minimizing agricultural impacts to land and water resources, have focused on promoting farmland conservation and management.

One of the greatest farmland conservation problems is soil erosion. Some studies have shown that a six–inch reduction in topsoil can decrease average crop yields 41%. Soil erosion can also increase the cost of crop production as fertilizers and other chemicals are used to compensate for soil loss. Sedimentation from farmland erosion also has been cited by the Kentucky Division of Water as causing 30% of the water quality problems found in streams and rivers across the state and 28% of the pollution problems in lakes. Runoff from farmlands has so greatly impacted five of the state's public lakes that they can no longer be used for swimming, fishing, or drinking water supplies.

State Cropland Erosion Rates Declining, But Still High at 8.51 Tons/ Acre/Year

The most common form of soil erosion affecting Kentucky's agricultural land, particularly cropland, is sheet and rill erosion. This type of erosion is caused when water moves across the land's surface removing soil in a fairly uniform layer. The USDA Soil Conservation Service estimated in 1987, (the most recent year for which information is available), that croplands in Kentucky lost an average of 8.51 tons of soil per acre each year. This was an improvement since 1977 when an average of 9.4 tons of soil were eroded annually from each acre of cropland. This rate, however, is still well above the tolerable limit of 5 tons/ acre, according to SCS. Average pastureland erosion rates also declined in Kentucky between 1977 and 1987, from 6.4 tons to 3 tons/acre/year. **(Fig. 20)**.

Figure 20
Average Farmland Soil Erosion Rates in Kentucky



Note: 1987 data most recent available.
Source: U.S. Department of Agriculture, Soil Conservation Service, 1991

Soil loss from farmland impacts productivity and also causes water quality problems. Erosion rates from Kentucky cropland and pastureland have improved since 1977. However, they are still well above tolerable limits.

406,000 Highly Erodible Farmland Acres Retired; 90,000 Farmland Conservation Plans Prepared

Soil erosion rates vary across the state, as well as from one farm to another. The USDA Soil Conservation Service reported the following in 1987:

- 758,000 acres (18%) of Kentucky cropland experienced erosion rates of 5 tons/acre/year or more. Approximately 3.4 million acres (81%) of cropland had an annual soil loss of less than 1 ton per acre.
- Erosion rates of 5 tons/acre/year occurred on 229,000 acres of the state's pastureland. More than 4.6 million acres of pastureland in the state lost less than 1 ton/soil/acre each year.

Reducing soil loss on highly erodible farmland is the focus of the national Conservation Reserve Program enacted by Congress in 1985. In Kentucky, 1.4 million acres of farmland are considered highly erodible. To date, 406,000 acres, or 29% of the state's highly erodible farmland, have been retired from use under the Conservation Reserve Program. While this represents a significant increase since 1987 when 149,000 acres were enrolled, continual efforts to retire these lands are needed. Farmers in the program are paid up to $60 per acre to set aside their lands from production to reduce erosion. In 1990, Kentucky farmers were paid $24 million through this set–aside program.

The 1985 National Farm Bill required conservation plans for all farms enrolled in USDA programs. These plans were to be prepared by 1990 and implemented by 1995. According to the Division of Conservation, nearly 90,000 farm plans have been developed in Kentucky. The plans include best management and other conservation practices designed to address animal waste, water supply, water quality, soil erosion, and other potential problems relating to environmental quality.

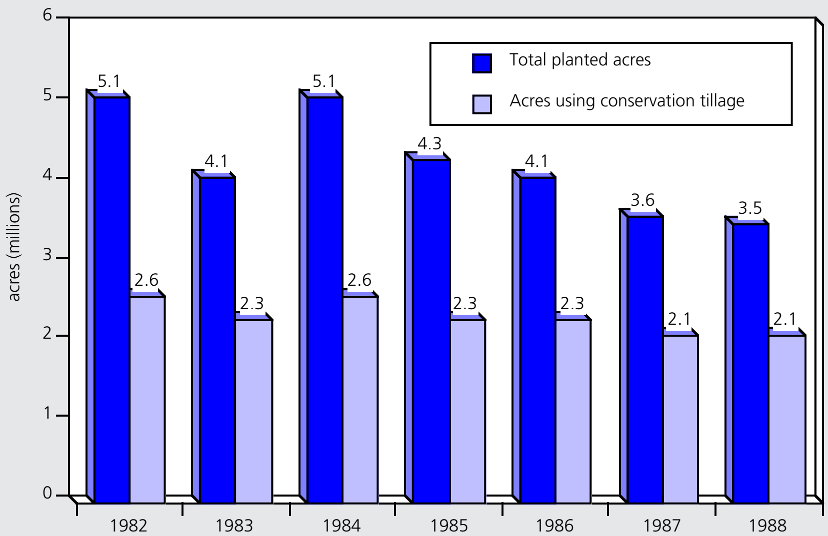
Farming Practices Increasingly Used to Protect Soil; Conservation Tillage Used on 2.1 Million Acres of Cropland

State and federal efforts have been successful in promoting farming practices in the state that reduce soil erosion. For example, Kentucky currently leads the nation in the percentage of cropland in conservation tillage, a group of farming techniques that disturb less soil. Conservation tillage is practiced on 2.1 million of the state's cropland **(Fig. 21)**. In conservation tillage, crop residues are left on fields to hold the soil and protect it from erosion. In addition to reducing erosion, this method of farming also helps cut energy and labor costs.

The most popular method of conservation tillage is mulch till in which crops are planted into the residue of previously grown crops **(Fig. 22)**. This technique accounted for 37% of all conservation tillage used in Kentucky during 1988. Reduced till, which minimizes soil tilling, is also an integral part of conservation practices. The use of no till farming in Kentucky remained fairly constant between 1982 and 1988 and was used on 27% and 22%, respectively, of the acreage in conservation tillage. No till involves planting the crop in untilled soil using a mechanized planter and applying herbicides to kill existing vegeta-

Figure 21

Kentucky Farmland Acreage in Conservation Tillage



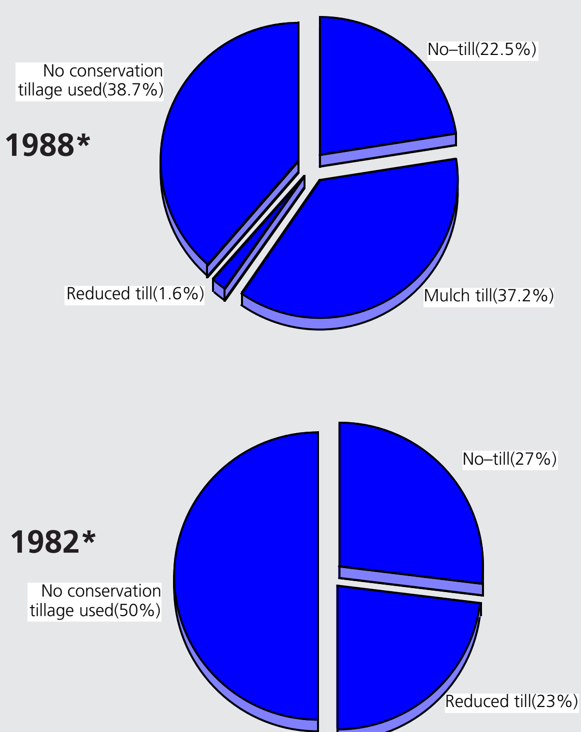
Note: 1988 data most recent available.

Source: National Association of Conservation Districts, 1991

Conservation tillage was used on 62% of the state's cropland in 1988 to minimize soil disturbance and erosion. Kentucky leads the nation in the percentage of cropland in conservation tillage.

Figure 22

Conservation Tillage Methods Used in Kentucky



**based on total planted acres*

Note: 1988 data most recent available.

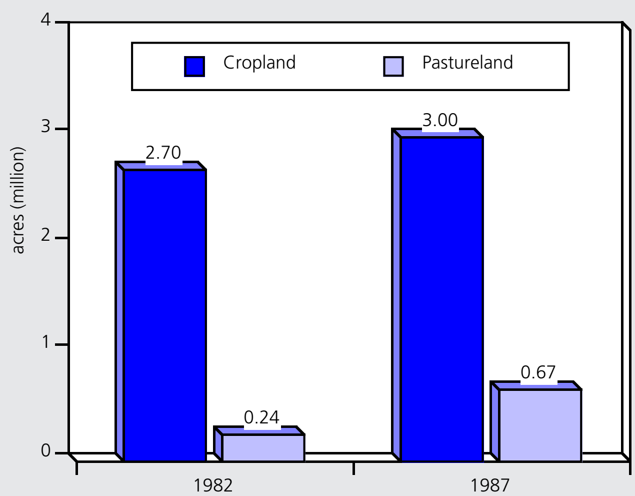
Source: National Association of Conservation Districts, 1982–88

The most popular farmland conservation tillage method used in Kentucky is mulch till. This involves planting crops into the residue of previously grown crops.

tion and control weeds.

While steady progress is being made in reducing agricultural erosion, more remains to be done. The USDA Soil Conservation Service estimated in 1987, that 3 million acres of cropland and 669,500 acres of pastureland were still in need of erosion control measures **(Fig. 23)**. Continued local and statewide efforts are needed to reduce farmland erosion rates to tolerable limits and protect downstream areas from siltation and pollution.

Figure 23
Kentucky Farmlands in Need of Erosion Control



Note: 1987 data most recent available.
Source: USDA Soil Conservation Service, National Resource Inventories, 1982 and 1987

While progress has been made in reducing agricultural erosion, more remains to be done. In 1987, 3 million acres of cropland and 669,000 acres of pastureland in Kentucky were still in need of erosion control measures.

406 State Permits Issued to Control Waste from Livestock Operations

More than 2.4 million cattle and 975,000 hogs and pigs were raised on farms in the state in 1989. Together with horses, poultry, and sheep, they produce more than 820 million cubic feet of manure each year in Kentucky.

Runoff pollution from animal waste is a particular concern when livestock are concentrated in small areas and confined for long periods of time. This is often the case for dairy, hog, and poultry operations. Dairy operations are primarily concentrated in the Central and Bluegrass regions of the state. Five counties—Barren, Shelby, Fleming, Nelson, and Hart—lead the state in the number of dairy operations. Hog and pig production is largely located near the corn producing areas of Western Kentucky, primarily in Union, Breckinridge, Nelson, Hardin, Graves, and Grayson counties.

The exact number of confined dairy and hog operations in Kentucky is unknown. However, in 1982, an estimated 4,000 operations existed. At that time, the Kentucky Division of Conservation estimated about 2,000 of these confined livestock operations were in need of a waste management system. The Division is currently conducting a survey to update the status of these operations and their waste management needs.

Most livestock waste management systems consist of stacking the solid waste and storing the liquids in holding ponds or lagoons. These systems can cost from $1,000 for a simple push–off platform and daily hauling, to $150,000 for a complex mechanical system for large operations. Since 1986, some livestock operations have been required to have a permit from the Kentucky Division of Water to control animal waste runoff into surface waters. Currently, the Division permits 406 farmland waste management operations. The U.S. Soil Conservation Service is also promoting the use of artificial wetlands to treat animal wastes. Twenty-eight systems are currently permitted and the Kentucky Division of Water is monitoring their effectiveness.

In addition to these confined operations, larger livestock herds may contribute to water quality problems. This is especially true of those located near streams or in karst and sinkhole areas. The degree to which these operations are affecting water quality is difficult to assess. The Division of Water has indicated, however, that nonpoint source runoff from livestock operations is a major problem in the Green River Basin where 26 streams may be impacted. In addition, 18 streams in the Salt River Basin are affected by waste from livestock operations as are several tributaries of the Ohio, Mississippi, Kentucky, Tennessee, and Little Sandy river basins.

Three public lakes are impacted by runoff from livestock operations: Reformatory Lake in Oldham County, Taylorsville Lake in Spencer and Anderson counties, and Sympson Lake in Nelson County. Runoff from livestock operations is also affecting the groundwater resources of the Royal Spring area in Scott County, and at least three wetlands in Western Kentucky.

Agricultural Chemicals

Pesticides and fertilizers are widely used in Kentucky to enhance crop production. The use of agricultural chemicals has resulted in larger yields of corn, hay, and soybeans throughout the state. However, chemicals used in farming can affect the environment in several ways. Pesticide and nitrogen fertilizer residues remain in soils and wash into streams or can leach into the ground, impacting water used for drinking, swimming, and fishing. In Kentucky, as elsewhere in the nation, the public is increasingly concerned about the possible health effects of pesticides in food.

The level of environmental contamination from agricultural chemicals has not been thoroughly assessed in Kentucky, even though half of the state's land area is farmland. With limited state historical information on the use of agricultural chemicals, assessing trends is difficult.

37,000 Pesticides on the Market; 300 Registered During the Last 21 Years

About 1,200 different active pesticide ingredients are currently registered in the U.S. Only a few, however, are used to create the 37,000 commercially available pesticide formulas. The production of organic pesticides, particularly herbicides, increased almost 700 percent between 1960 and 1980, as chemicals replaced mechanical methods for controlling weeds. Three hundred new pesticides were registered in the U.S. between 1967 and 1988.

In the past, emphasis was on the development of persistent pesticides that did not readily decompose. However, concern about the long–term environmental and health effects resulting from persistent pesticides, such as DDT, has led to the development of pesticides that are more short–lived. These compounds are more toxic when first applied, but break down rapidly in the environment.

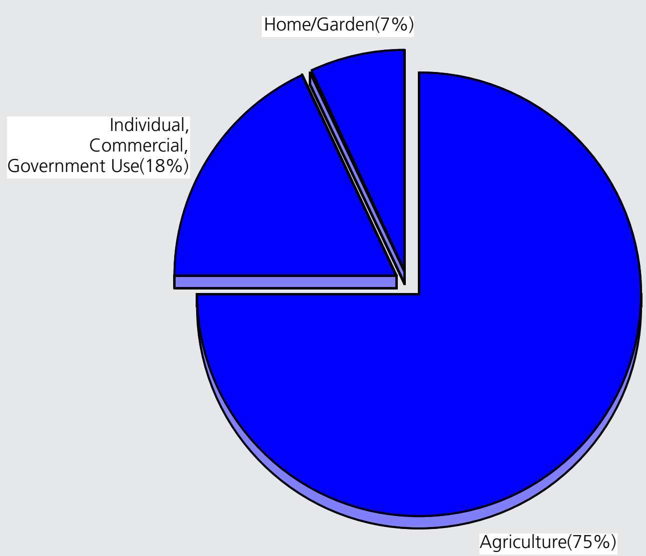
9 Million Pounds of Agricultural Pesticides Sold by 480 Dealers in Kentucky During 1990

The U.S. Environmental Protection Agency estimates that nearly 75% of the 2.7 billion pounds of pesticides sold in the U.S. during 1988 were used for agricultural purposes **(Fig. 24)**. Kentucky ranks twentieth in the nation in the use of agricultural pesticides, according to the National Pesticide Usage Database.

National reports indicate that pesticide sales have remained relatively constant in recent years, after increasing steadily during the 1960s and 1970s. The amount used for agriculture is considered stable, and is expected to show a decline in the future due to the use of more potent pesticides which are applied in lesser amounts. More efficient use of pesticides and lower farm commodity prices are also expected to contribute to less usage.

Pesticide sales data can provide a general view of the type and amount purchased for use in the state. Comprehensive sales data was collected by the Kentucky Department of Agriculture Division of Pesticides for the first time in 1990. The pesticide sales survey of 480 dealers in the state revealed that more than 9 million pounds of active agricultural pesticide ingredients were sold in Kentucky during 1990. Herbicides represented 74% of the total

Figure 24
Estimated U.S. Pesticide Use By Sector



Source: US EPA Office of Pesticide Programs, 1988

Approximately 75% of the 2.7 billion pounds of pesticides sold in the U.S. during 1988 were used for agricultural purposes. Kentucky is ranked twentieth in the nation for the use of agricultural pesticides.

Figure 25
Pesticide Sales in Kentucky by Type (1990)

Pesticide type	Lbs. of active ingredient	% of total sales
Herbicides	6,689,508	74.1
Fumigants	1,206,467	13.4
Insecticides	871,017	9.6
Plant Growth Regulators	160,175	1.8
Fungicides/Antibiotics	94,931	1.0
Desiccants	11,250	0.1
Total	**9,033,348**	**100**

Source: University of Kentucky College of Agriculture, 1991

A state survey of 480 pesticide dealers revealed more than 9 million pounds of active agricultural pesticide ingredients were sold in Kentucky during 1990.

25 Pesticides Account for 95% of State Sales; Greatest Use in Christian, Daviess, Todd, and Union Counties

sales reported, followed by fumigants and insecticides **(Fig. 25)**.

Twenty–five pesticides accounted for 95% of all the pesticide purchases in Kentucky during 1990 **(Fig. 26)**. Atrazine, the active ingredient in many herbicides, leads in state use. This chemical is widely used to control broadleaf weeds in corn. More than 1.6 million pounds of atrazine were sold in Kentucky in 1990, accounting for about 18% of all reported pesticide sales.

Pesticide sales were greatest in the western counties of Union, Christian, Daviess, Todd, and Logan **(Fig. 27)**. Union, Christian, Daviess, and Logan counties led the state in corn production and Todd County was among the top five counties in the production of winter wheat and dark fire–cured tobacco.

Kentucky farmers spent an estimated $52 million for agricultural chemicals in 1987, a slight decline from 1982 when $57 million was expended. According to the U.S. Census of Agriculture, pesticides were applied to 46% of Kentucky farms in 1987 to control insects. Weed control followed at 36%, and chemicals to control plant disease were used on 8%

of the state's farms.

Studies Detect Pesticide Contamination in Wells, But Most at Levels Below Health Standards

The U.S. EPA is responsible for setting standards for pesticides in the environment. Since 1975, public drinking water systems have been required to test for six regulated pesticides: endrin, lindane, methoxychlor, toxaphene, 2,4–D, and 2,4,5–T. Standards have been proposed for 14 additional pesticides. Public drinking water systems will begin testing for these substances in 1993.

Between 1980 and 1990, regular testing of public drinking water systems in Kentucky discovered only two instances of detectable levels of regulated pesticides in the finished water. In both cases, endrin was found in systems supplied by surface water. The levels detected, however, did not exceed health standards.

The state monitors surface waters annually for pesticides at 12 stream stations. Most pesticides do not persist in water for a long period of time, so analyses are also performed on sediment and fish tissue to determine how much has accumulated. These tests are limited in their scope because U.S. EPA action levels have been developed for only 18 toxic chemicals in fish, including the pesticides aldrin, chlordane, DDT, and endrin. The Ohio River Valley Sanitation Commission monitors pesticides in the Ohio River. The agency has identified pesticides as a major cause of impairment in the Ohio River, contributing 41% of the pollution problem.

Monitoring and bioaccumulation studies detected unsafe levels of pesticides in fish at several locations in the state. These discoveries led to the posting of four fish consumption advisories currently in effect in Kentucky, although none have been associated with agricultural pesticides. Two of the advisories are attributed to the pesticide chlordane. Structural application of chlordane for termite control is thought to be the primary contributor of this contamination. The other two advisories

Figure 26

Kentucky Pesticide Sales for Top 25 Chemicals (1990)

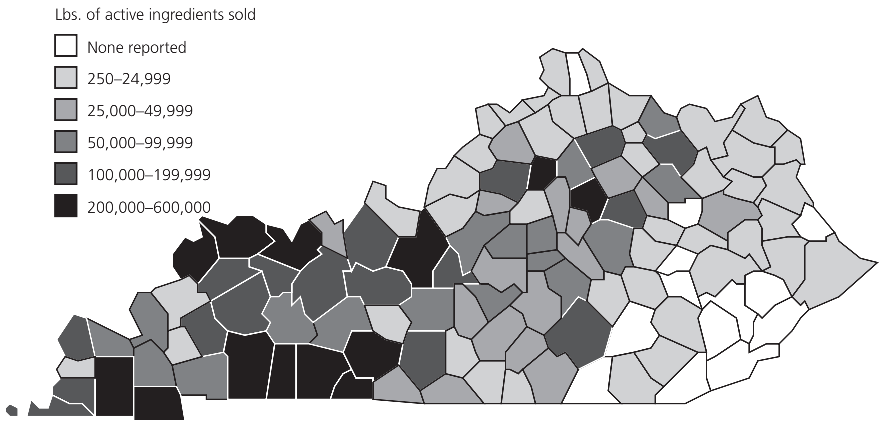
Active Ingredient	Statewide Sales (lbs.)[1]	Major Use[2]
Atrazine	1,665,586	corn
Butylate	1,422,537	corn
Methyl Bromide	1,120,904	tobacco
Alachlor	863,541	corn/soybeans
Metolachlor	609,467	corn
Trifluralin	334,604	soybeans
EPTC	326,898	corn
Glyphosate	288,400	corn/soybeans
Acephate	269,963	tobacco
Carbofuran	269,269	corn/tobacco/alfalfa
Pendimethalin	218,050	corn/tobacco/soybeans
Simazine	190,744	corn
Maleic Hydrazine	160,114	tobacco
Chlorpyrifos	101,204	corn/tobacco/alfalfa
Paraquat	100,841	corn/soybeans
2, 4–D	91,372	corn/wheat
Bentazon	89,017	corn/soybeans
Cyanazine	85,708	corn
Endosulfan	79,205	tobacco
Fluazifop–p–butyl	64,690	soybeans
Pebulate	56,216	tobacco
Metalaxyl	54,667	tobacco
1, 3–DCP	53,037	tobacco
Malathion	38,595	alafalfa/wheat
Metribuzin	38,093	soybeans
Total	**8,592,722**	

Note: Sales data are based on pounds of active ingredients.
Source: [1]Kentucky Division of Pesticides, 1991
[2]University of Kentucky College of Agriculture, 1991

Twenty–five pesticides accounted for 95% of all pesticides sold in Kentucky. Atrazine, the active ingredient in many herbicides, is widely used to control broadleaf weeds in corn and leads in state use.

State pesticide sales were greatest in Union, Christian, Daviess, Todd, and Logan counties. A 1989 survey of 200 private water wells in Christian, Todd, Hickman, and Henderson counties revealed 31% had detectable levels of triazines, a group of pesticides commonly used in Kentucky. One well exceeded standards for these chemicals.

Figure 27
Pesticide Sales in Kentucky (1990)



Source: Kentucky Division of Pesticides, Pesticide Sales Survey data,1991

involve toxic PCB contamination.

Agricultural chemicals were detected in some groundwater supplies during a non–scientific rural well water testing project sponsored by the University of Kentucky and the Kentucky Farm Bureau. However, the levels detected were generally below those which cause adverse health effects. Thirty–one percent of the 200 private water wells tested in Christian, Todd, Hickman, and Henderson counties during 1989 had detectable levels of triazines. Only one well exceeded health standards for this pesticide. Additional water well studies are underway in other counties.

In 1990, the Kentucky General Assembly enacted legislation mandating that the state manage groundwater for the "health, welfare, and economic prosperity of all citizens." The legislation directed the University of Kentucky to assess the impacts of agricultural practices on groundwater and to establish research programs designed to determine the agricultural management practices necessary to protect groundwater resources. A multi-agency planning group was created for these purposes and short and long-term ground-water monitoring studies have been designed.

Early monitoring results from approximately 1,000 samples collected at locations in ten counties - Bourbon, Daviess, Fleming, Hickman, Logan, Russell, Shelby, Jessamine, Woodford, and Todd - revealed that agricultural chemicals including nitrate/nitrogen, atrazine, and alachlor were detected at various levels in the streams, wells, and springs sampled. Average levels were below drinking water standards and health advisory levels, although some individual samples did exceed safe levels for these chemicals.

Bacterial contamination from animal and human waste was also assessed and was found in most water sources tested. Results of the bacteriological tests conducted by the University of Kentucky in ten counties revealed the following:

Type Water Source	% Samples With Fecal Bacteria (human or animal waste) Contamination
Spring	84
Well	29
Stream	94

Generally, contamination from agricultural activities was detected in most of the ground and surface waters sampled. More monitoring results are scheduled to be released in July 1992. Results of this study and others indicate that a more comprehensive statewide assessment is needed to thoroughly evaluate pesticide contamination in groundwater and assess trends.

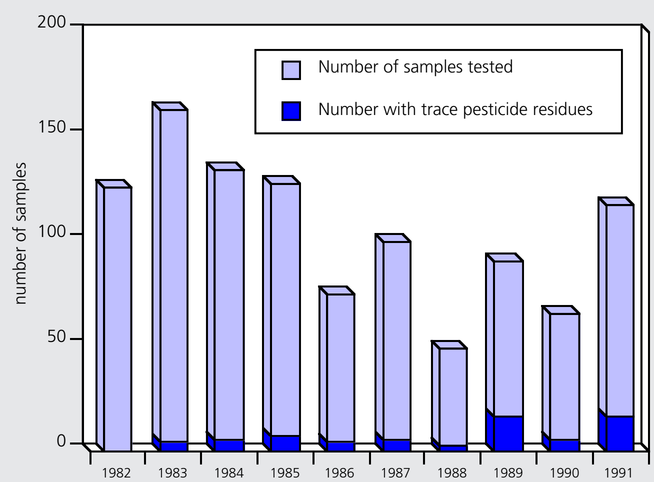
Pesticides in Food Monitored Randomly; Few Instances of Contamination Detected in Kentucky Produced Commodities

People applying pesticides or working in the area of their manufacture generally receive the greatest exposure to these chemicals. However, everyone is exposed to these compounds at some level either in food, drinking water, or air. Seventy–three percent of the people responding to a 1987 survey conducted by the Food and Marketing Institute expressed concern regarding the health effects of pesticide residues in food.

The U.S. Food and Drug Administration and the U.S. Department of Agriculture are responsible for monitoring pesticides in food. The Kentucky Department of Health Services supplements the work of these federal agencies by randomly sampling raw agricultural commodities produced in Kentucky such as fruits, vegetables, milk, and, more recently, fish for most of the common pesticides. The more complex pesticides, such as aldicarb and 2,4,5–T, are not routinely monitored. They are checked only if a grower indicates their use.

Food samples tested rarely contain pesticides above acceptable tolerance levels, according to state officials. During the last ten years, two samples have been discovered with high pesticide residues out of the average 70 to 90 random samples analyzed each year **(Fig. 28)**. Should a food product be found to be contaminated with high levels of pesticides, the Department can impose an embargo under the Kentucky Food, Drug, and Cosmetic Act.

Figure 28
Results of Pesticide Testing for Fruits and Vegetables Grown in Kentucky



Source: Kentucky Cabinet for Human Resources, 1992

Food samples randomly tested in Kentucky rarely contain pesticides above acceptable tolerance levels. During the past ten years, only two samples had high pesticide residues detected.

Disposal of Unused Agricultural Chemicals a Concern; Some Efforts to Collect Old Pesticides Made

Improper disposal of pesticides can also contaminate water. Empty agricultural pesticide containers are currently allowed to be disposed at municipal solid waste landfills. Most facilities, however, will not accept agricultural containers because of liability concerns.

Improperly stored and disposed pesticides pose risks to the environment and to individuals. For example, in 1990, approximately 2,000 pounds of Paris Green, a pesticide banned from use in the 1950s, was found stored in a Lawrenceburg feed and grain warehouse. The improperly stored pesticide was a serious health risk to anyone who came in contact with it. Removal of the pesticide proved costly to the warehouse owners who were required by the state to dispose of the Paris Green as a hazardous waste because it contained high levels of arsenic, lead, and other heavy metals. The property owners were unable to receive any assistance from the manufacturer of the pesticide.

It is not known how many agricultural chemical containers are sold and disposed in Kentucky. The Division of Pesticides is considering regulations to require recordkeeping to inventory containers. The state recently sponsored a farm chemical amnesty collection program in Marshall and Caldwell counties. During the two days free collection was offered, 90 vehicles brought empty containers and approximately 5,400 gallons of unused pesticides in need of disposal. While the program may be expanded statewide due to its success, the high costs may inhibit such an effort. The cost for the two–day collection, laboratory analyses, and proper disposal was about $700,000. Most of the services were donated by state government and private sources. Among those donating services were the Tennessee Valley Authority who provided trained personnel, and LWD, a commercial hazardous waste incinerator located in Marshall County, which donated transportation and disposal services. A similar statewide program is estimated to cost an average of $100,000 to $200,000 per county.

Farmers need a mechanism to properly dispose of old, unused agricultural chemicals and containers. This is especially critical because of the importance and vulnerability of groundwater, which many Kentuckians rely on for drinking. This resource can easily become contaminated by these chemicals and is virtually impossible to clean up once it has been degraded. There is also a widespread need for providing disposal services for chemicals which have been banned or restricted, according to agriculture experts. Many farms have been storing unused chemicals because proper disposal is expensive. Some suggest that disposal provisions should be made at the time chemicals are banned. The disposal of agricultural chemicals presently purchased in Kentucky is expected to be less of a problem in the future due to the use of dissolvable and reusable containers, and more potent pesticides which require far less volume to be effective.

State Pesticide Inspections Double; 70,000 Pesticide Applicators Certified by State

The Kentucky Division of Pesticides has the authority to regulate the sale, use, manufacture, and distribution of pesticides. Inspections and enforcement actions by the Division during the past two fiscal years are as follows:

Year	Inspections	Enforcement Actions
89–90	5,210	1,500
90–91	11,000	1,218

According to the Division, enforcement actions have declined due to the agency's higher visibility resulting from the increased number of inspections. The U.S. EPA reports that Kentucky operates a model program in the Southeastern Region of the U.S. and conducts an excellent inspection and enforcement program. To further ensure quality, state inspectors will be required to be certified by the U.S. EPA beginning in 1993.

The Division also certifies and licenses applicators of pesticides. Currently, 70,000 applicators are certified for the commercial or private application of restricted–use pesticides. This is a significant increase since 1985 when 23,000 applicators were certified **(Fig. 29)**. According to state officials, this increase occurred because methyl bromide, which is used on tobacco, became a restricted–use pesticide. Individuals seeking certification, most of whom are farmers, are required to view educational materials regarding proper pesticide use under the supervision of a county extension agent.

Pesticide dealers and commercial applicators must also be licensed. To be licensed, applicants must pass a test on the proper handling and application techniques of pesticides. Additional testing is required within an area of specialization. These examinations, which were approved by the U.S. EPA, will be significantly upgraded in June 1992 to reflect the latest information on pesticide use, and to ensure that licensed applicators are thoroughly familiar with proper handling techniques. All eight states in the U.S. EPA's Southeastern Region will begin using a uniform examination that will enable certified applicators to operate within all participating states. Applicators, however, will still be required to be licensed within each state of operation.

Figure 29

Number of Kentucky Certified Pesticide Applicators

Type	1985	1991
Commercial Applicators	3,000	10,000
Private Applicators	20,000	60,000
Total	**23,000**	**70,000**

Source: Kentucky Division of Pesticides, 1991

Currently, 70,000 applicators are certified for the commercial or private application of restricted-use pesticides. The increase occurred because methyl bromide, which is used on tobacco, became a restricted-use pesticide.

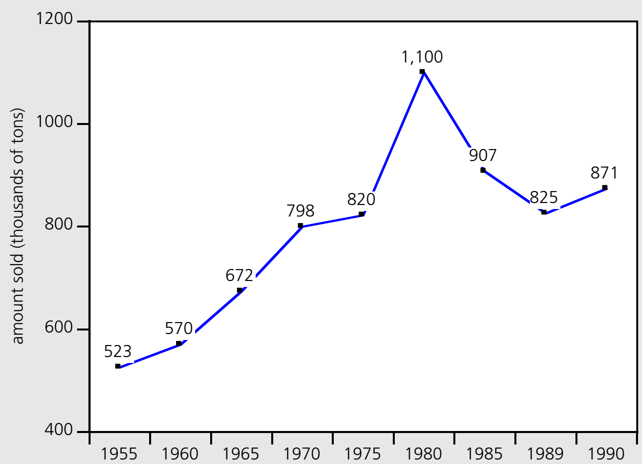
Fertilizer Sales in Kentucky Peak in 1980 at 1 Million Tons; Decline 21% Since Then

In 1989, an estimated 825,000 tons of fertilizer were sold in Kentucky. Fertilizer sales peaked in Kentucky during 1980, but have since declined 21% **(Fig. 30)**.

Commercial fertilizer was applied to more than 85% of the farms in Kentucky during 1987. This percentage was the same in 1982, according to the U.S. Census of Agriculture. Most of the fertilizer was used on cropland (85%), with the remainder used on pastureland.

The greatest agricultural use of fertilizer in the state occurs in the Pennyroyal Region, and the least amount in the Eastern Region of Kentucky. However, specific application rates are higher in Eastern Kentucky where more intensive crops such as tobacco are grown.

Figure 30
Fertilizer Sales in Kentucky



Note: Fertilizer sales provide a general estimate of the relative amount used. Some fertilizers used in Kentucky are purchased out-of-state and are not reflected in the totals shown.

Source: Kentucky Agricultural Statistics Service, 1991

Nitrogen fertilizer sales peaked in Kentucky during 1980. Sales have since declined, but rose again in recent years. A 1989 water well survey detected some level of nitrates in all the 888 wells tested. Six percent exceeded the drinking water standard for nitrate.

Nitrate Contamination of Public Drinking Water Rare in Kentucky; 6% of Water Wells Tested Exceed Nitrate Standards

Soil runoff containing nitrogen fertilizer can impact water quality. Phosphorus, an ingredient in fertilizer, contributes to nutrient problems in streams and lakes. High levels of nutrients can result in low oxygen levels causing unhealthy fish populations, as well as odor and taste problems in lakes used as drinking water sources.

Nitrogen/nitrate levels, which are most influenced by runoff from cropland and livestock operations, rarely exceed health standards in treated public water supplies in Kentucky. Between 1980 and 1990, only one public drinking water system detected an exceedence of the nitrate standard in the finished water.

Nitrates are also being detected in private water wells in Kentucky. All of the 888 private water wells sampled by the University of Kentucky in 1989 had nitrate detected, and about 6% exceeded the drinking water standard. A 1990 survey of 2,032 wells revealed 4.2% had unsafe levels of nitrates.

Surface water monitoring by the Division of Water for nitrate/nitrogen at 36 stream stations across the state indicated that between 1983 and 1988, no significant increase or decrease of this contaminant occurred at 29 of the stations. Six stations had decreasing levels of nitrogen/nitrate and only one station showed increasing levels.

105,656 Acres of Farmland Reduce Chemical Use

Some efforts have been made to promote the reduction of pesticide and fertilizer use on Kentucky farmland. One initiative, the Integrated Pest Management (IPM) program, provides farmers with insect, weed, and disease management information, coupled with a soil testing and fertilizer use recommendation service. The IPM program, operated by the Extension Service at the University of Kentucky, encourages farmers to apply pesticides and fertilizers only when needed. This is accomplished through weekly scouting of fields, notification of current or pending problems, control procedures, updated chemical recommendations, soil samples, and suggestions on next season's potential pests.

Although the program can have dramatic results–two Todd County farmers report saving $10,000 a year in chemical costs–it is not extensively used. In 1982, an estimated 117,558 acres of farmland were enrolled in the IPM program. In 1990, approximately 105,656 acres were enrolled in the program. The Extension Service currently has 57 farmers and 16,396 acres participating in a demonstration IPM project.

The U.S. Department of Agriculture recently offered a two–year experimental program in Shelby, Webster, and Butler counties to minimize pesticide and nutrient use on crops and promote environmentally–sound farming practices. Sixteen farmers in these counties are participating in the Integrated Crop Management pilot program. Results from the program are expected this year.

Some work is ongoing in Kentucky to assess the ability of biological alternatives such as viruses, parasites, and predators to control common agricultural pests. Bacterial agents are used to a limited degree to control moth and butterfly caterpillars. Wasp parasites have been used to control alfalfa weevils and noding thistles. Introduced predators, such as lady bugs, have not generally been successful for agricultural pest control, according to some Kentucky experts.

Thirty–one Organic Farms Certified by State; Demand for Organic Foods Increasing

Public and commercial interest in foods produced without the use of chemicals is growing nationally and in Kentucky. Thirty–one organic farms have been certified by the state since the voluntary program began in 1990. Certified farms are required to conduct soil tests and occasionally submit plant tissue and water analyses, in addition to being inspected at least once every year. The federal government is scheduled to issue regulations in 1993 which will standardize organic farming regulations. At that time, organic produce marketers selling more than $5,000 of organic produce will be required to be certified.

In Kentucky, the demand for organic foods is reported to be expanding, especially in the Louisville area among wholesale produce houses. Suppliers are interested in non–perishable organic foods, such as dry beans and grains, which are reported to be in short supply. Some organically grown tobacco from Kentucky is currently being marketed successfully in New Mexico.

Cooperative Efforts Needed to Benefit Farmers, Consumers, and the Environment

The conservation, management, and protection of Kentucky's farmland is a significant state challenge. In addition to promoting markets for agricultural products, continued efforts to preserve prime farmlands, reduce soil erosion, control animal waste runoff, and properly dispose of unused pesticides and their containers are needed. A more thorough analysis of pesticides in groundwater is also critical to better assess problems, monitor trends, and protect public health. The conversion of wetlands to agricultural lands also remains a highly debated state and national issue. (Wetlands are further discussed in the Natural Areas section of this chapter.)

Kentucky has a valuable agricultural resource. Its protection and management will require the combined efforts of state and federal agencies, universities, farm organizations, conservation districts, and individual farmers. Such a cooperative initiative is needed for Kentucky to promote sustainable agriculture that benefits farmers, consumers, and the environment, alike.◆

Forestry

Kentucky's forests have changed significantly during the last century. In the late 1800s, forests were being cut at tremendous rates to clear land for farms and supply a growing market for fuel and wood products. Only 252 acres of old–growth virgin forests remain in the state. Today, the clearing of forests is less common and forestland has increased steadily during the past 35 years.

The amount of land growing trees, however, does not provide a complete indicator of the health of Kentucky's forests. The diversity of the forest affects its usefulness for recreation, wildlife habitat, watershed protection, and as a supplier of wood products. The U.S. Forest Service (USFS), through periodic surveys, provides the most extensive data on the condition of the state's forests. These surveys, dating back to 1953, were reviewed in order to assess the trends and conditions of the forests of Kentucky.

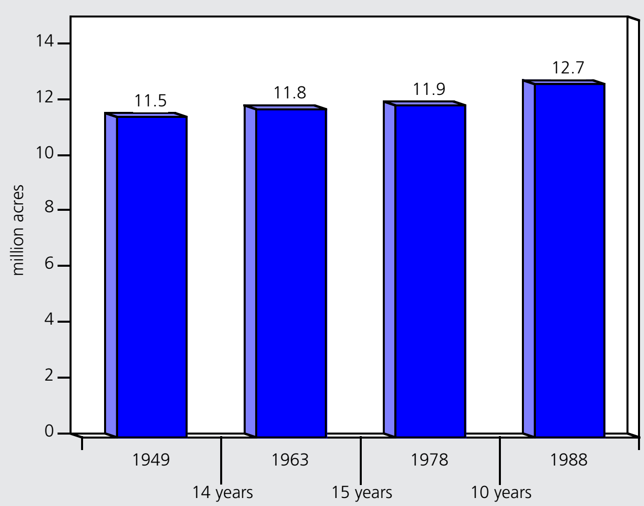
Forest and Ownership Trends

Forestland Increases to 12.7 Million Acres; Largest Percentage of Growth in Bluegrass Region

Kentucky's forests cover an estimated 12.7 million acres (49%) of the state's land area, according to the U.S. Forest Service. This is a 9% increase since 1949 when forests blanketed 11.5 million acres **(Fig. 31)**. Forestland varies from a low of 25,000 acres in Nicholas and Bourbon counties to a high of 423,000 acres in Pike County. The most heavily–forested areas lie in the eastern mountains of the state and include 670,000 acres of the Daniel Boone National Forest, the state's only national forest **(Fig. 32)**.

Regional forestland acreage has not changed significantly during the past 24 years, except in the Bluegrass area where acreage increased 38% between 1963 and 1988. Most of this change is attributed to the abandonment of farmland.

Figure 31
Forestland Acreage in Kentucky (selected years)



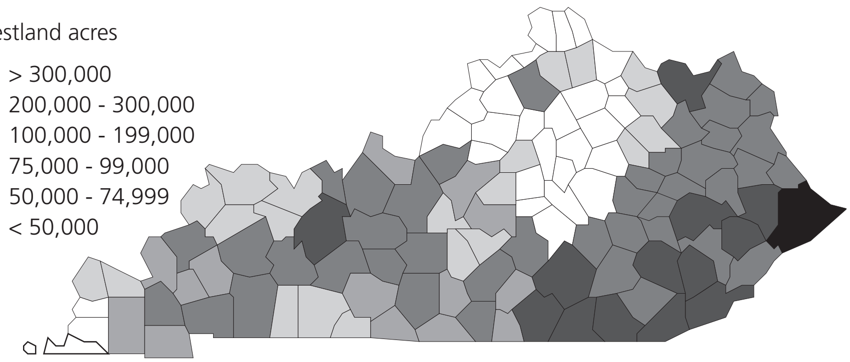
Note: 1988 data most recent available.
Source: U. S. Forest Service Surveys, 1953–1988

Kentucky's forests cover nearly half of the state's land area. Forestland is increasing, up 9% since 1949.

The acreage of Kentucky forests varies from county–to–county. The most heavily forested areas occur in Eastern Kentucky.

Figure 32
Commercial Forestland in Kentucky

Forestland acres
- > 300,000
- 200,000 - 300,000
- 100,000 - 199,000
- 75,000 - 99,000
- 50,000 - 74,999
- < 50,000



Source: U. S. Forest Service Survey, 1988

Most Forests Comprised of Oak and Hickory; Decrease in Forested Wetlands Affect Diversity

Kentucky's forests are made up of seven major forest types **(Fig. 33)**. These forest groups and their status are as follows:

◆ **The white oak/red oak/hickory group is the primary forest type occurring in Kentucky.** Acreage of these species increased slightly, up 4% over the last ten years, and are now found on 77% of the forestland in the state.

◆ **The white and red pine group comprises less than 1% of the forests in Kentucky.** These species experienced a 156% increase in acreage since 1975, from 14,000 acres to 37,000 acres in 1988. The white and red pine forest group includes red cedar which is considered a "pioneer species" that usually takes over abandoned fields. The group also includes white pine, a popular species used for tree planting across the state.

◆ **The northern hardwood group composed of sugar maple, beech, and basswood, comprises 3% of the forests in Kentucky.** This group experienced the next greatest change in acreage, from 514,000 acres in 1975 to 661,000 acres in 1988, an increase of 29%. This may be due to lighter harvesting and the greater shade tolerance of these species.

◆ **The oak/pine forest group increased 7% in acreage since 1975.**

◆ **The greatest decrease in forest species statewide was in the oak/gum/cypress group.** Acreage of these species declined 19% over the past ten years. This forest type, composed of swamp chestnut oak, red maple, and swamp tupelo, is primarily found in Western Kentucky. The loss of forested wetlands where these species typically occur, has been cited as the reason for this decline. Only 20% of Kentucky's remaining 360,000 acres of wetlands are forested.

◆ **Another decreasing forest type is the elm/ash/maple group.** These species, considered high value to the sawtimber industry, cover about 5% of the forest acreage and decreased 11% since 1975.

◆ **The southern pine group decreased 5% over this 13–year period.**

Figure 33
Statewide Changes in Kentucky's Forests

Forest Group or Class	1975	1988	Acreage Change	% Change
	(thousand acres)			
White/Red Pine	14.3	36.6	22.3	156
Loblolly/Shortleaf Pine	679.4	645.5	–33.9	–5
Oak/Pine	800.1	857.9	57.8	7
Oak/Hickory	9,169.4	9,515.8	346.4	4
Oak/Gum/Cypress	82.0	58.8	–23.2	–28
Elm/Ash/Red Maple	642.7	571.3	–71.4	–11
Northern Hardwoods	514.1	661.4	147.3	29
All Groups	**11,902**	**12,347.3 ***	**445.3**	**3.7**

**only includes commercial forestland*

Note: 1988 data most recent available.

Source: U.S. Forest Service Surveys, 1975–1988

Kentucky's forests are composed of seven major forest groups. The oak and hickory group make up 77% of the state's forests. Some forest species are declining due to harvesting and the loss of wetlands.

Plantations in Western Kentucky and Strip Mine Reclamation Lead to Regional Increases in Southern Pine; Sawtimber Trees Increase While Seedlings Decrease Statewide

While statewide acreage of southern pine is decreasing, a review of regional changes in Kentucky's forests shows a slightly different picture **(Fig. 34)**. Increases in southern pine acreage are occurring in Western Kentucky, where the forest industry maintains pine plantations. Concerns have been expressed that these pine plantations are impacting the state's forest diversity in certain areas. While these species are steadily increasing in Western Kentucky, they still only make up 3% of the total forested acreage in the Western Region of the state, 6% in the Western Coalfield Region, and 7% in the Pennyroyal Region. The increase in pine in Western Kentucky may also be attributed to coal mine reclamation and natural regeneration of Virginia pine.

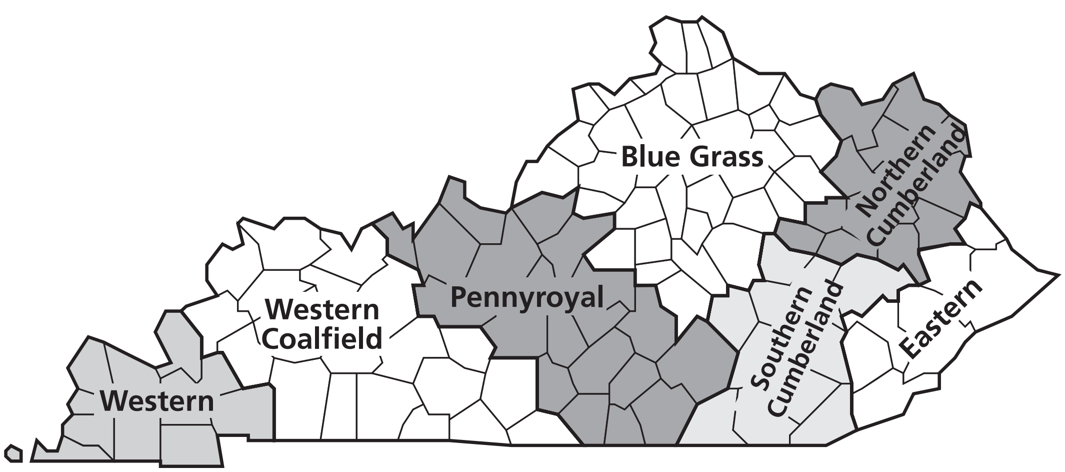
The average tree size in the state has also changed since 1975 **(Fig. 35)**. These changes are consistent with the succession of the forest from seedling, sapling, poletimber, to sawtimber. The state acreage of sawtimber increased 14% since 1975 and now makes up 58% of the forests. Sapling and seedling forestland acreage decreased from 32% in 1975, to 16% in 1988.

Figure 34
Regional Changes in Kentucky's Forests

Region/Forest Type	1963	1975	1988
	Forest Acres (thousands)		
West			
Southern Pine	0	7	21
Oak/Pine	6	20	19
Oak/Hickory	298	521	618
Elm/Ash	26	115	88
Northern Hardwood	n/a	20	24
Western Coalfield			
Oak/Pine	16	87	103
Oak/Hickory	724	1438	1361
Elm/Ash	226	137	157
Oak/Gum	69	49	52
Pennyroyal			
Southern Pine	58	149	168
Oak/Pine	48	124	215
Oak/Hickory	879	1704	1640
Elm/Ash	96	75	65
Northern Hardwoods	n/a	75	158
Blue Grass			
Southern Pine	30	88	73
Oak/Pine	22	119	220
Oak/Hickory	283	750	1036
Elm/Ash	178	254	194
Northern Hardwoods	n/a	117	145

Region/Forest Type	1963	1975	1988
	Forest Acres (thousands)		
Southern Cumberland			
Southern Pine	132	261	214
Oak/Pine	275	251	159
Oak/Hickory	870	1561	1629
Elm/Ash	54	11	39
Northern Hardwoods	n/a	58	89
Northern Cumberland			
Southern Pine	99	122	70
Oak/Pine	151	155	100
Oak/Hickory	917	1476	1613
Elm/Ash	22	47	26
Northern Hardwoods	n/a	47	22
East			
Southern Pine	30	51	39
Oak/Pine	38	43	39
Oak/Hickory	775	1716	1615
Maple	104	41	74
Northern Hardwoods	n/a	63	107

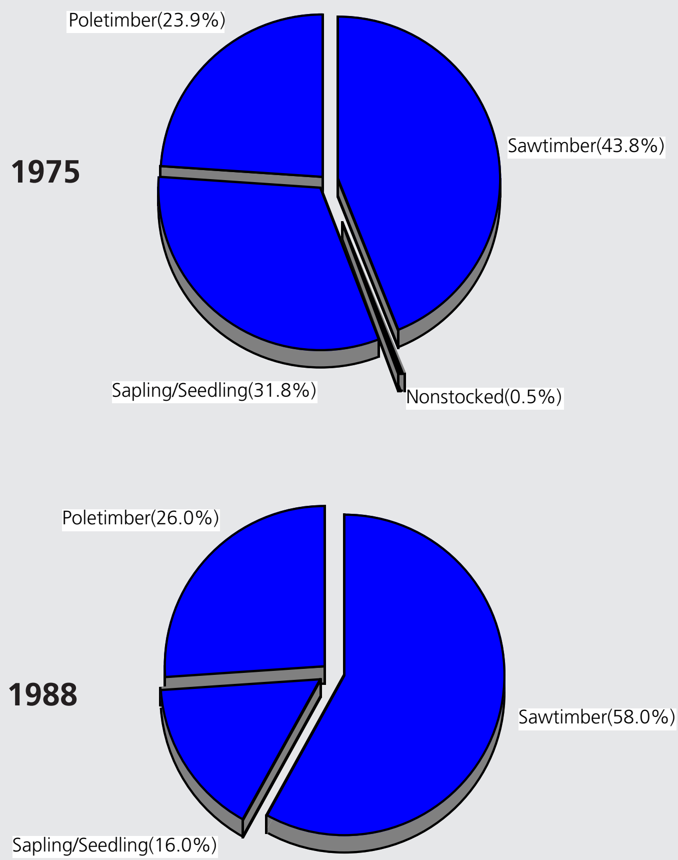
n/a - not available
Note: 1988 data most recent available.
Source: U.S. Forest Service Surveys, 1953–1988



Forestland Regions in Kentucky

Regional trends in forest species indicate that while statewide acreage of Southern pine is declining, this species is increasing in the Western Kentucky and Pennyroyal regions. This is attributed to forest industry pine plantations, strip mine reclamation, and natural regeneration of Virginia pine.

Figure 35
Kentucky Timberland by Stand–size



Note: 1988 data most recent available.
Source: U.S. Forest Service Surveys, 1975–88

The average tree size in Kentucky forests has increased since 1975. These changes are consistent with forest succession from seedling, sapling, poletimber to sawtimber.

Forest Ownership Trends Show Increases in Corporate, Private, and National Forest-land; Decrease in Forest Industry Acres

The ownership of Kentucky's forests has remained fairly constant during the last 40 years with the majority (92.5%) privately owned. National forests comprise 4.8% of the state's commercial forestland, with the remaining 2.7% in state, local, and other public ownership. Acreage in these categories of ownership have increased slightly, with the exception of the forest industry **(Fig. 36)**. Forest industry acreage decreased 20% between 1975 and 1988, primarily due to the divesting of wood yards in Kentucky by out–of–state pulp mills.

The ownership of Kentucky forestland varies from region–to–region. For example, a majority of the national forest acreage is in the Southern Cumberland Region where the Daniel Boone National Forest (DBNF) is located. The largest acreage owned by the forest industry occurs in the Northern Cumberland Region (68,000 acres) followed by the Western Region (46,000 acres). During the past ten years, some changes in ownership can be seen at the regional level. Forest industry acreage increased in the Pennyroyal Region 38% and in the Bluegrass Region from no acreage in 1975, to 7,000 acres in 1988. Forest industry acreage decreased in all the other regions of the state.

Corporations also own forestland throughout Kentucky. Many of these companies are engaged in coal, gas, petroleum, or mineral extraction. A regional assessment of corporate ownership reveals increases in the Pennyroyal, Western Coalfield, Western, Eastern, Northern Cumberland, and Bluegrass regions. In the Eastern Region of the state, 25% of the forestland, about 542,000 acres, is owned by corporate interests.

In Kentucky, 84% of forestland is owned by individuals, with the average–size woodlot being 24 acres. Approximately 25% of these landowners are farmers and 23% are retired. These numerous small and fragmented tracts of forestland makes the management of this resource difficult. According to a USFS forest landowner survey conducted in 1978, most Kentuckians do not view their forestland as a financial asset, but rather perceive it as a part of their environment to be used as needed. To many Kentuckians, whether forested or not, the land is part of their heritage and to own it is reward enough.

Figure 36
Ownership of Kentucky's Forests

Owner	1949	1968	1975	1988	Current %
		(thousand acres)			
National Forest	406	453	588	594	4.8
Other Public*	270	289	306	329	2.7
Forest Industry	n/a	228	255	204	1.6
Private	10,770	10,743	10,751	11,219	90.9
Total	**11,446**	**11,713**	**11,900**	**12,346****	**100.0**

n/a—not available
** other public includes federal, state, country, and municipal ownership*
***only includes commercial forestland*
Note: 1988 data most recent available.
Source: U.S. Forest Service Surveys,1953–1988

A majority of forests in Kentucky are privately owned. All the categories of ownership experienced increases in acreage during the last 40 years, with the exception of the forest industry, which declined 20% since 1975.

Timber Production and Consumption

Sawtimber Removals up 30% Since 1975; Timber Growth Currently Exceeds Removals

Logging boomed in Kentucky in the early 1900s. By 1907, timber production in the state peaked at 913 million board feet. At that time, timber–related employment was estimated at 30,000. Timber production declined to its lowest level, 207 million board feet, in 1925.

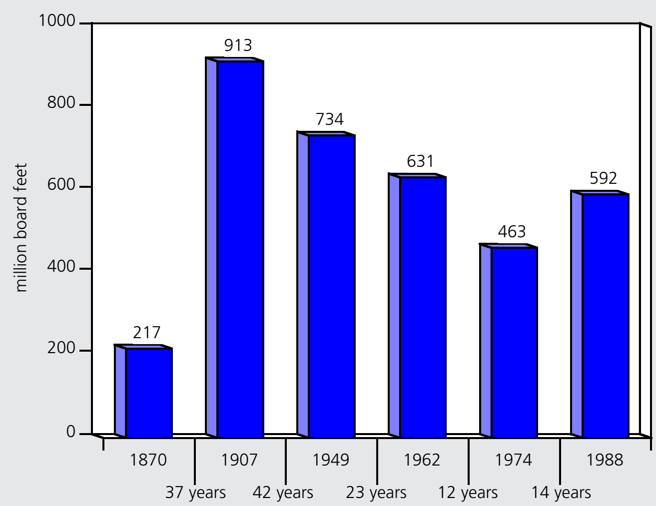
Use of Kentucky's forest for timber products is again on the upswing due to an increase in both U.S. and foreign demand. The state produced 811 million board feet of lumber in 1988, a 30% increase since 1974 **(Fig. 37)**. In 1989, the forest industry employed 24,000 people and produced over $900 million in sales. The total annual impact of this industry in Kentucky, including payroll and timber purchases, amounts to $1.4 billion a year.

Timber stands are better stocked than they have been in many years. In 1956, nonstocked or poorly stocked stands occurred on one–fifth of Kentucky's forestland. Now all forested acres are considered adequately stocked with trees. The volume of sawtimber per acre has increased 32% since 1975 to 3,710 board feet per acre.

Currently, timber is harvested at a 1 to 2.6 removal/growth rate which would indicate that Kentucky's forests are being cut at sustainable levels **(Fig. 38)**. More desirable species, however, such as select red oaks, are harvested at an almost even removal/growth ratio.

The overall quality of timber harvested from Kentucky forests has declined slightly since 1975. Logs with few defects, such as rot, stains, fire damage, knots, and sweeps, are graded as 1 or 2 high quality logs. In 1975, 39% of the volume harvested was log grade 2 or better. In 1988, 35% of the logs produced were graded 2 or better, a 4% decline in the volume of high quality logs harvested from Kentucky forests.

Figure 37
Removal of Sawtimber* from Kentucky Forests (selected years)



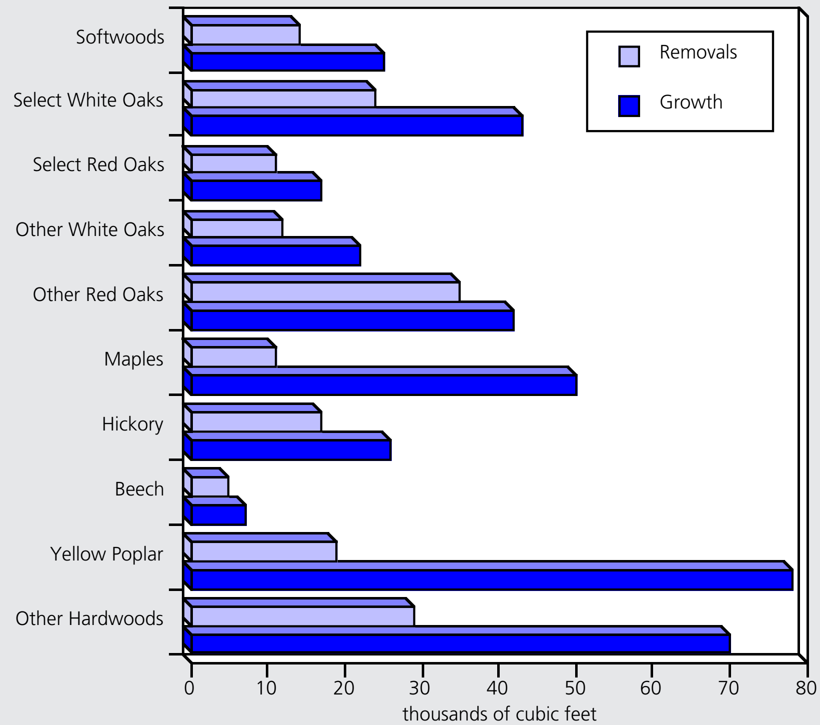
**Sawtimber trees are live trees of commercial value at least 9" inn diameter for softwoods and 11" in diameter for hardwood containing at least one 12' log. A log 18" in diameter and 16' long contains 230 board feet.*

Note: 1988 data most recent available.

Source: U.S. Forest Service Surveys, 1953-1988

Harvesting Kentucky's forests for timber products rebounded in 1988 due to an increase in U.S. and foreign demand.

Figure 38
Annual Growth and Removal of Trees, Saplings, and Seedlings in Kentucky



Note: A log 18" in diameter and 16' long contains 23.7 cubic feet.

Source: U.S. Forest Service Survey, 1988

Overall, timber is being harvested at a 2.6 to 1 growth/removal rate which would indicate that Kentucky's forests are currently being cut at sustainable levels. Some tree species, however, are being logged at a greater rate.

Poor Timber Harvesting Practices Hurting Timber Quality; Shift Away from Clearcutting on National Forest

The primary method of harvesting timber in Kentucky has been highgrading. This method involves removing quality trees and leaving undesirable or damaged trees, allowing little room for new growth. This type of harvesting has adversely affected the quality of timber available in the state. In 1987, an estimated 4.4 million acres of forestland were in need of timber stand improvements, primarily due to highgrading, according to the U.S. Department of Agriculture's Soil Conservation Service.

Efforts to improve timber quality and to promote proper management and harvesting have been initiated in Kentucky. The Kentucky Division of Forestry (KDF) has written 8,420 management plans covering 663,000 acres of forestland during the past ten years. These plans, however, cover less than 6% of the state's commercial forestland acreage. KDF has also assisted private landowners in properly harvesting their timber. Since 1985, the Division has marked 35,000 acres of trees for harvesting at a minimal cost to the landowner. Unfortunately, few forest owners take advantage of this service and highgrading continues to be the dominant harvesting practice in the state.

Another method of timber removal is clearcutting. The USFS has historically used clearcutting as its primary harvesting method in the Daniel Boone National Forest in Eastern Kentucky. This method involves the removal of all trees in average blocks of one to 40 acres. Trends show a slight increase in the volume of timber harvested from the Daniel Boone Forest during the last 30 years, from 30.8 million board feet in 1970, to 35.1 million board feet in 1990.

The USFS recently announced a shift from clearcutting to a modified shelterwood harvest method which is designed to retain a certain volume of trees per acre. The USFS has moved away from clearcutting to shelterwood cuts in the Daniel Boone National Forest to reduce the visual impacts of clearcutting and to provide a more diverse wildlife habitat while continuing to produce quality sawtimber. Public pressure to reduce timber harvests on national forests, will likely result in less timber production from the Daniel Boone National Forest in the future and more reliance on private lands for wood products.

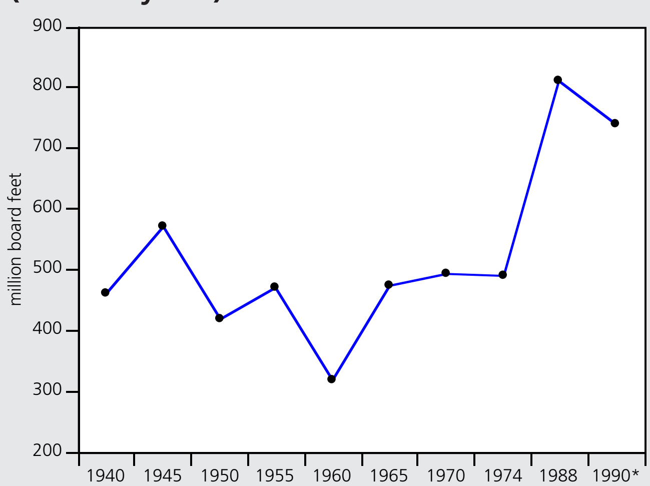
Federal cost–share funds are available to assist private landowners in Kentucky better manage their forests. An average of $74,000 has been appropriated annually to the state for the past seven years for tree planting, and to improve the quality of timber stands. In 1991, the state received $90,000 in federal cost–share funds to finance forest management on private land.

Production of Lumber from Kentucky Forests Near Record Levels in Recent Years; Pulpwood Production Declining

More timber harvested in Kentucky is used for lumber than any other wood product. In 1988, lumber production accounted for 89% of the state's total timber harvest. Ninety–four percent of the sawtimber harvested and received at primary manufacturing plants was hardwood, with oak the most important lumber species.

Lumber production in the state peaked in the early 1900s at 900 million board feet and declined dramatically to 200 million board feet during the Depression. Since that time, production has fluctuated, based on the economy. Lumber production steadily increased to near record levels of 811 million board feet in 1988 but declined to 740 million board feet in 1990 **(Fig. 39)**. Kentucky ranks fourth in the U.S. for hardwood production and supplies 11% of the nation's hardwood demands. Currently, 520 sawmills in the state are capable of processing an average annual volume of 20 million board feet of timber. There are also 40 lumber drying kilns, 400 pallet mills, and 16 wood preserving plants in the state.

Figure 39
Lumber Production in Kentucky (selected years)

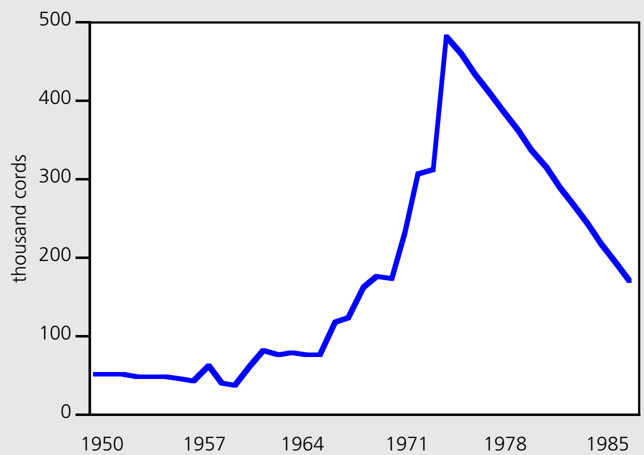


**preliminary data from the Kentucky Division of Forestry*
Source: U.S. Forest Service Surveys, 1978-1988

More wood was harvested in Kentucky and used for lumber than any other wood product. Since 1960, lumber production has steadily increased. Kentucky's 1988 lumber production reached near–record levels but declined some-what in 1990.

In comparison, production of pulpwood and wood residues used to produce paper and other products has declined over the years **(Fig. 40)**. The opening of Kentucky's first paper and pulpmill in Hawesville in 1967 and another in Wickliffe in 1970 increased production of pulpwood until it peaked in 1972 at about 480,000 cords of wood. Pulpwood production dropped to 168,000 cords in 1986. The decrease in pulpwood harvesting is primarily due to out–of–state pulp mills divesting their wood yards in Kentucky to minimize transportation costs. The production of other products such as veneer and cooperage logs also continues to decline in Kentucky. New global markets, however, will likely increase demand for all Kentucky forest products.

Figure 40
Pulpwood Production Trends in Kentucky (selected years)



Note: 1985 data most recent available.
Source: U.S.Forest Service Forest Surveys, 1978–1988

Wood harvested for use as woodpulp for paper production has declined in Kentucky. This is due to out–of–state pulp mills divesting their wood yards in the state to minimize transportation costs.

Recreation and Forests

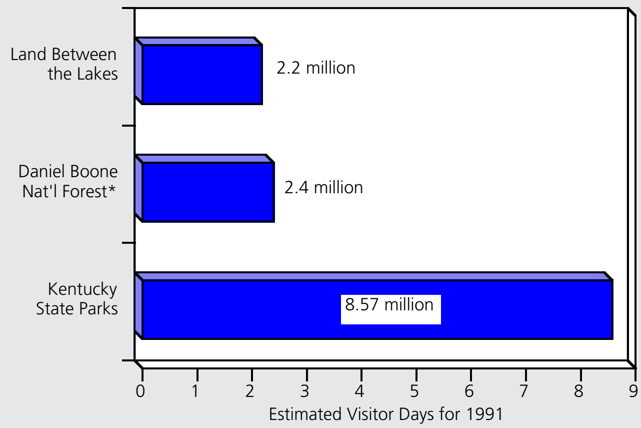
Recreation in Kentucky Parks and Forests Increasing; Managing Demands on Limited Public Lands a Growing Challenge

Recreational use of public forests is increasing at the state's 15 resort, 20 recreational, and nine historic parks; six state forests; 24 state nature preserves; 25 state wildlife management areas; as well as at the four national park or recreation areas and the Daniel Boone National Forest located in the state **(Fig. 41)**.

While publicly–owned forestland represents less than 8% of the state's total forest acreage, it provides for the bulk of Kentucky's tourism industry. The 670,000–acre Daniel Boone National Forest received more than 2.4 million visitors during 1990, an increase of 100,000 from 1989. The Tennessee Valley Authority's Land Between the Lakes is comprised of about 170,000 acres in Western Kentucky. This resort area has had more than 2 million visitors annually, and is a large contributor to the region's $200 million tourism industry. Kentucky's state parks, which consist of approximately 42,000 acres, had 8.57 million visitors in 1991, an increase of 182,000 since 1983.

There has been an increase in the use of both public and private forests for outdoor recreation and this trend is expected to continue. Recreational uses of public forests include hunting, fishing, hiking, and off–highway vehicle use. It is estimated by the Adventure

Figure 41
Recreational Use of Public Forests and Parks in Kentucky (selected areas)



** 1990 data*

Source: U.S. Forest Service, 1990; Kentucky Department of Parks, 1991; Tennessee Valley Authority, 1991

Recreational use of Kentucky's forests is increasing. While public forestlands represent only 8% of the total forest acres in Kentucky, they support the bulk of the state's tourism industry.

Travel Society, Inc. that in the future, 70% of all tourism will be based on natural and cultural resources. In 1991, there were 233 campgrounds with 13,691 campsites located throughout Kentucky. About half of these campgrounds are privately owned.

Increasing use of limited public land have caused conflicts in the Daniel Boone National Forest, particularly between hikers and off–road vehicle operators. Managing increased recreational use on public forests, in concert with other uses, will continue to be a major challenge in Kentucky.

Forest Threats

Fires a Major Threat to Forests; 50% Purposely Set in 1990

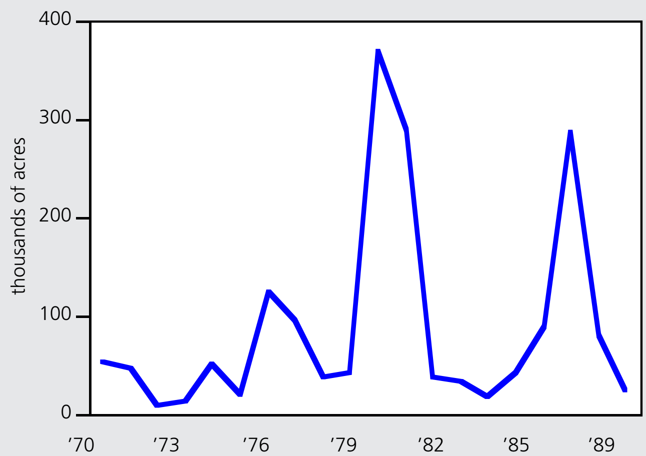
Fire is one of the greatest threats to the productivity, diversity, and use of Kentucky's forests. Every year, thousands of acres of forests are scarred and their diversity and value reduced because of forest fires. It is estimated the timber value loss to Kentucky is $85.58 for each acre of forestland burned. This amount does not include impacts to water, wildlife, or recreation values.

More than 1.7 million acres of Kentucky forestland have burned during the last 19 years **(Fig. 42)**. About 31% of these fires were accidently caused by individuals burning fields or trash and another 28% were purposely set **(Fig. 43)**. In 1990, however, 50% of the forest fires in the state were caused by arson.

Most of the forest fires occurring during the last 19 years have been located in the heavily–forested eastern portion of the state **(Fig. 44)**. Three Eastern Kentucky counties sustained substantial losses from forest fires. These counties and the acreage burned between 1970 and 1989 are as follows:

- ◆ Floyd County - 171,000 acres
- ◆ Breathitt County - 151,000 acres
- ◆ Pike County - 133,000 acres

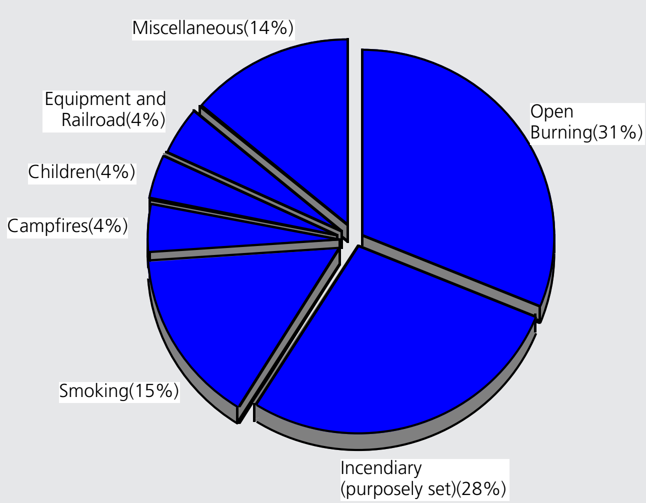
Figure 42
Forestland Burned in Kentucky



Source: Kentucky Division of Forestry, 1991

Fire is one of the greatest threats to forest productivity, diversity, and use. During the last 19 years, 1.7 million acres of Kentucky forestland have burned.

Figure 43
Causes of Forest Fires in Kentucky

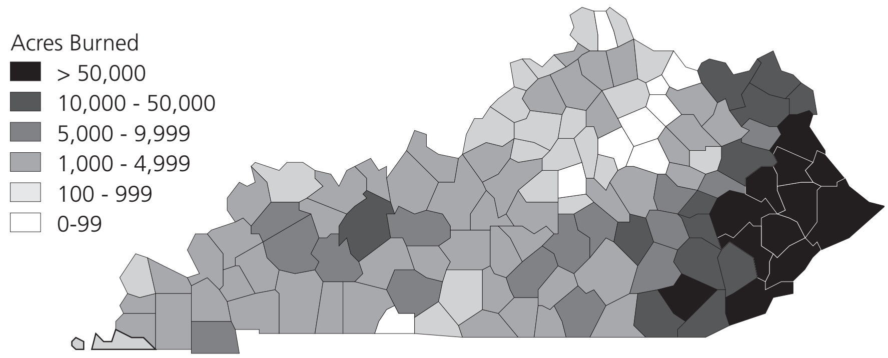


Note: Based on 19-year average (1970-1989)
Source: Kentucky Division of Forestry, 1991

About 31% of the forest fires in Kentucky were accidently caused and 28% were purposely set between 1970 and 1989. In 1990, however, arson was responsible for 50% of the forest fires in the state.

Most forest fires occur in the heavily–forested eastern region of the state. Floyd, Breathitt, and Pike counties led the state in acres burned during the past 19 years. Efforts to prosecute arsonists have improved, but more remains to be done to reduce forest fires in Kentucky.

Figure 44
Forested Acres Burned in Kentucky (1970–89)



Source: Kentucky Division of Forestry, 1991

During the past 25 years, the state issued 13,000 misdemeanor and 245 felony violations to individuals caught or suspected of setting fires. The state also prosecuted 15,000 cases with a conviction rate of 62%, and recovered $261,000 in fire suppression costs. Both the forest industry and the state offer rewards for information leading to the prosecution of arsonists. There has also been growing recognition in the courts, particularly in the Central and Western regions of the state, as to the seriousness of forest fire violations. In Central Kentucky, the state has a 100% conviction rate for individuals charged with setting forest fires. Still, much more needs to be done to reduce the number of forest fires in the state.

Oak Decline, Air Pollution Affecting Kentucky's Forests; Full Impacts Unknown

Kentucky's forests are repeatedly threatened by insects, disease, and pollution. The state has not generally committed resources to assess forest health and problems, even though the timber and forest recreation industries greatly contribute to the state's economy and quality of life. Gypsy moth movement into Kentucky from the Northeastern U.S. is a potential threat to the forests of the state. Some gypsy moths have been found in the Commonwealth in widely scattered locations. A half–acre infestation did occur in the 1980s near Anchorage in Jefferson County, but was subsequently controlled.

Forest disease, including dogwood anthracnose and oak bacterial scorch, is being documented with increased frequency across the state in both urban and rural forested areas. Oak decline, which has been observed in the Eastern and Southeastern U.S., is a concern in Kentucky since more than 50% of the growing stock is oak species. The cause of oak decline is not known.

Ozone pollution, or smog, is now recognized as a growing threat to forests. A study commissioned by the state in 1988, revealed that ozone, an air pollutant associated with emissions from paint, solvents, inks, and gasolines, can negatively affect tree growth. While the study concluded that some forested areas are exposed to ozone levels that may decrease tree vigor and lead to increased dieback and decline, more information and research was needed to assess actual impacts. A discussion of ozone problems can be found in the Air Quality chapter of this report.

Another threat to forests is acid rain. Acid rain damage to spruce forests, particularly those at or above altitudes of 1,000 meters, has been recorded in the North Carolina Appalachian Region as well as in the Northeastern U.S. and Canada. The 1988 study concluded that Kentucky forests are not immediately at risk from acid rain damage due to species composition, altitude, and limestone buffering soils.

Forest Protection and Management

Tree Planting Used to Counter Fire; 56% of the Seedlings Purchased Used for Coal Mine Land Reclamation

To counter the impacts of forest fires, land damage from mining, and other activities, the state sells tree seedlings through its two nurseries. About 9 million seedlings are sold annually. An estimated 12,857 acres of land are planted with trees each year in Kentucky, based on an average of 700 seedlings per acre **(Fig. 45)**.

Fifty–six percent of the 9 million seedlings purchased from KDF's nurseries during fiscal year 1989–90 were used for coal mine land reclamation. The most popular species used for reclamation were: white pine, black locust, black alder, Virginia pine, shortleaf pine, loblolly pine, and the shrubs, bicolor lespedeza, and autumn olive.

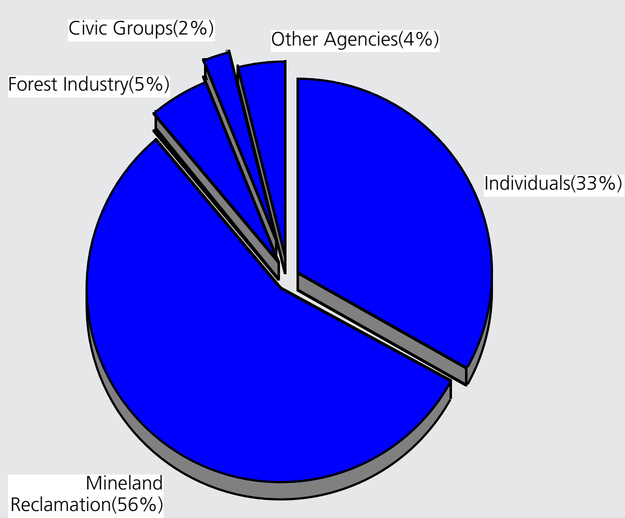
Individuals purchased 33% of the seedlings, with the most popular species being: white pine, scotch pine, black walnut, loblolly pine, Virginia pine, and white ash. Seedlings, primarily scotch pine, are supplying an increasing Christmas tree industry in Kentucky. This industry includes about 185 active growers, an increase from 25 in 1983.

Awareness of the importance of trees, particularly in urban settings for reducing noise and air pollution as well as improving aesthetics, has led to increased tree planting in communities across Kentucky. Federal grants for state and local tree planting have risen from $11,000 in 1988, to $500,000 in 1990.

A popular initiative in Kentucky involves the formation of local tree commissions to survey the health of trees and determine planting needs. In 1988, only one city had a local tree commission. By 1990, local tree commissions were active in 25 communities throughout the state. Calvert City recently established a tree commission and planted 250,000 trees at industrial sites. The city's goal is to plant 1 million trees. During 1990, KDF assisted 75 communities with urban forestry programs.

Figure 45

Tree Planting in Kentucky



Note: Based on purchases of 9,018,509 seedlings in fiscal year 1989–90 from the Kentucky Division of Forestry Nursery.

Source: Kentucky Division of Forestry, 1991

About 9 million tree seedlings are sold each year by the Kentucky Division of Forestry. More than half are purchased for mine land reclamation. The planting of trees in urban areas is increasing in Kentucky. Currently, 25 communities have established tree commissions to promote tree planting.

Erosion From Forests Declining; 10,000 Acres of Grazed Forestland Still Lose Over Five Tons of Soil Each Year

The control of erosion from forested watersheds has improved somewhat over the years, according to the U.S. Soil Conservation Service. The average soil erosion rate from rural forestland has declined from three tons an acre in 1982, to 1.48 tons an acre in 1987. While this reduction showed an improvement in controlling erosion, the Soil Conservation Service estimated that 10,000 acres of grazed forestland continue to lose more than 5 tons of soil per acre every year. More than 487,000 acres of forestland need to be established or reinforced with timber to control erosion, according to 1987 data. In addition, soil loss during actual harvesting activities can be excessive due to road building and harvesting practices.

In Kentucky, runoff from timber harvesting and forestry activities is controlled through voluntary measures. Since 1981, KDF has assisted landowners improve 40,500 acres of forests around watersheds to minimize erosion. Tree planting, installation of water bars to minimize runoff from roads, and seeding logging roads are some of the methods used to reduce forestland erosion. KDF also encourages loggers to use best management practices to control erosion during timber harvesting.

While steady progress has been made in controlling runoff pollution from forestlands, many forestry activities are still degrading water quality in ten of the state’s 13 river basins. Kentucky received $1.5 million in federal funds in 1991 to assist landowners address forestland erosion and protect streamside corridors. The Forest Stewardship Program, established under the 1990 federal Farm Bill, provides cost–share funds for forestland conservation and management. This initiative should greatly assist in promoting more productive and healthy forests in Kentucky.◆

Natural Areas

One of Kentucky's most outstanding natural qualities is the diversity and beauty of its landscape. The varied terrain and abundant rivers and streams support the state's nearly 60,000 species of plants and animals. Natural areas, however, are steadily disappearing or being degraded due to development pressures, pollution, and other land disturbing activities.

The loss of biodiversity—individual species and subspecies and the ecosystems they inhabit—can have significant ecological, recreational, and economic impacts. State efforts to preserve and maintain ecosystems, the units formed by plant and animal communities as they interact with their physical environment, is the focus of this section.

Small Percentage of Kentucky's Original Wetlands, Prairie Lands, and Forests Remain

Kentucky's natural resources have changed dramatically in 200 years as witnessed in the following:

- Less than 1,000 acres of the 23 million acres of original forests remain uncut and free of disturbance.
- Wetlands, which are considered to be some of the most productive natural areas, once covered 1.6 million acres in Kentucky but have been reduced to 360,000 acres, much of which are degraded.
- Only 200 acres of the state's original 2 million acres of prairie lands that once supported huge populations of bison and other animals remain.
- There are no areas left intact with the original Bluegrass savanna vegetation once common in Central Kentucky.
- The state's vast cave resources have been damaged by sewage, trash, and vandalism.

The result of these changes includes the loss of habitat for many native species, especially the more sensitive ones. Opportunities for recreation and other social uses of these areas are lost as well. Most importantly, the beauty and diversity of nature is impacted and with it, Kentucky's ecological soundness and heritage **(Fig. 46)**.

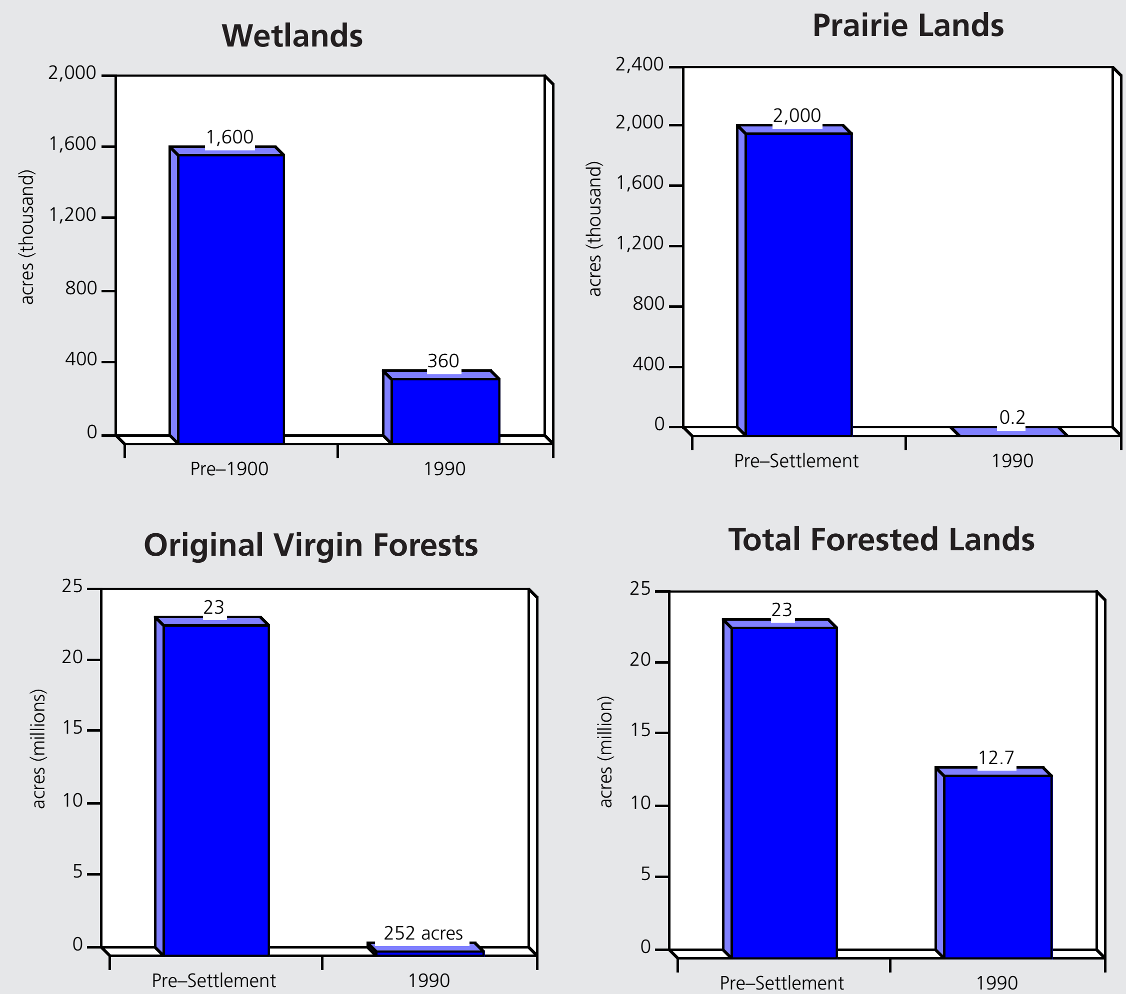
32,127 Acres Protected as Natural Areas; 60% Federally Owned

While many important natural areas have been lost, there are still many to be protected. Some state and federal agencies, as well as private conservation groups, are working to protect unique and important natural areas in Kentucky. A natural area is defined as containing an aquatic or terrestrial ecosystem that has essentially retained or recovered its presettlement conditions, or is a "least disturbed" example of a natural ecosystem.

According to the Kentucky Nature Preserves Commission's (NPC) Natural Heritage Database, only 32,127 acres of the state's 25.8 million acres are protected as natural areas **(Fig. 47)**. The federal government manages 60% of Kentucky's protected natural areas which include the following:

- Three areas in Trigg County at Land Between the Lakes;
- The Big Woods Natural Area in Hart County managed by the National Park Service;
- Four natural areas in Marshall, Calloway, and McCracken counties managed by the Tennessee Valley Authority;
- A ten–acre natural area in Trigg County managed by the U.S. Corps of Engineers;
- Two national wilderness areas, Clifty in Menifee County and Beaver Creek in McCreary County, managed by the U.S. Forest Service; and
- Three natural areas in Leslie, Laurel, and Wolfe counties also managed by the U.S. Forest Service.

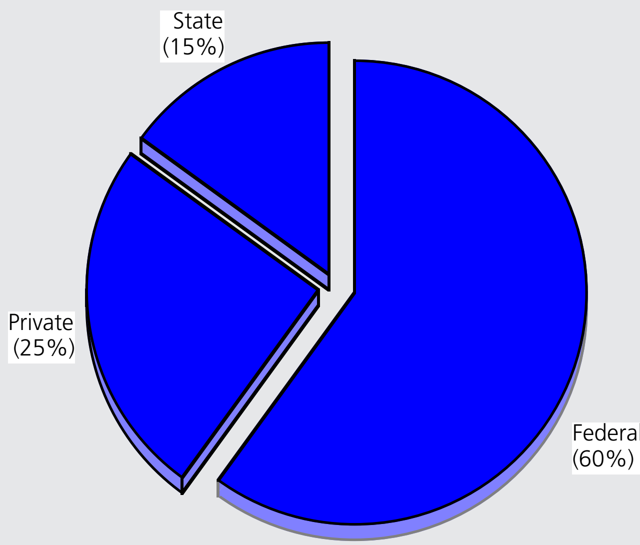
Figure 46
Loss of Natural Resources in Kentucky



Source: Kentucky Nature Preserves Commission, 1991

Little of Kentucky's land is like it was 200 years ago. Over 80% of the state's original wetlands have been destroyed. Only 200 of the state's original 2 million acres of prairie remain. Of the state's 23 million acres of forest, less than 1,000 acres now remain uncut and free of disturbance.

Figure 47
Protected Natural Areas in Kentucky



Note: Based on 32,127 acres, percentages rounded.
Source: Kentucky Nature Preserves Commission, Natural Heritage Database, 1991

Managed and protected natural areas represent far less than 1% of Kentucky's total land area. The majority of these areas are federally or privately owned.

About 15% of the acres protected as natural areas are owned by the state and managed by the following:

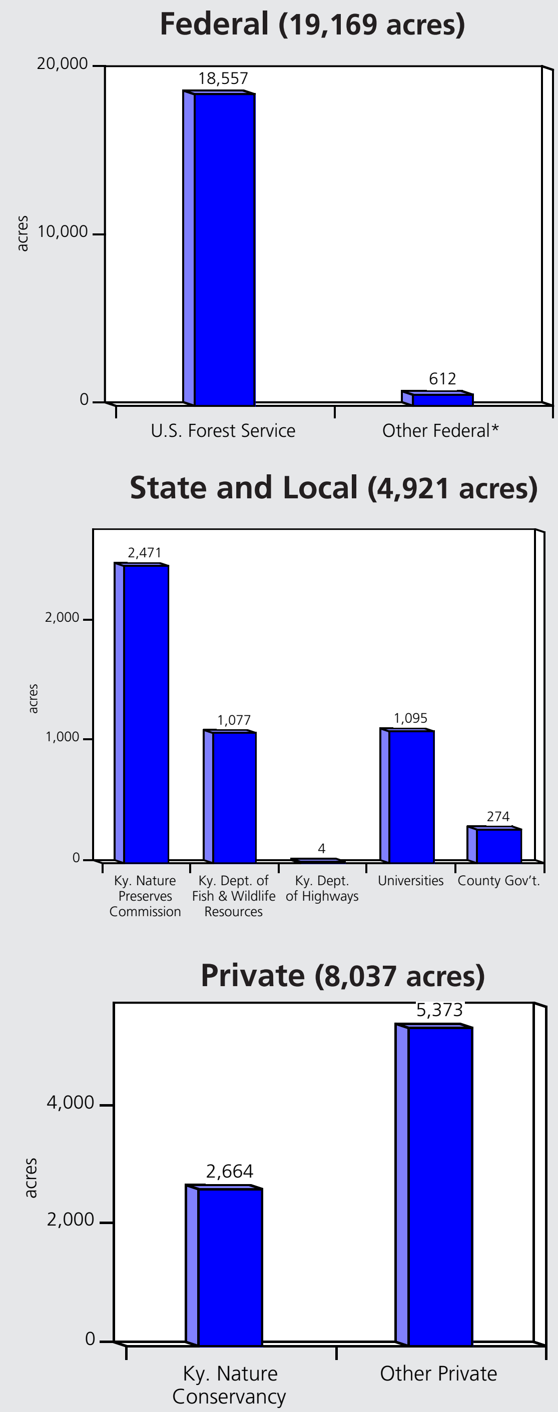
- NPC manages 24 nature preserves in 18 counties.
- The Kentucky Department of Fish and Wildlife Resources (KDFWR) has established three mussel sanctuaries in Livingston, Mason, and Marshall counties.
- The Kentucky Department of Highways manages two, two–acre natural areas in Grayson and Robertson counties.
- Two natural areas, Murphy's Pond in Hickman County and Lilly Cornett Woods in Letcher County, are protected by universities.

Lexington/Fayette County manages the only natural area owned by a local government, the 274–acre Raven Run Nature Sanctuary.

There are also several privately–owned natural areas that range from one acre to 700 acres. The Nature Conservancy, a nonprofit national conservation organization, through its Kentucky Chapter, manages 24 areas in 21 counties. The private sector owns approximately 25% of the natural area acreage currently protected in the state **(Fig. 48)**.

Protected natural areas include two national wilderness areas in the Daniel Boone National Forest and 24 state nature preserves. A lack of acquisition funds has limited the state's ability to protect unique natural areas in Kentucky.

Figure 48
Protected Natural Areas in Kentucky



**Other federal include the National Park Service, the Tennessee Valley Authority, and U.S. Corps of Engineers.*

Source: Kentucky Nature Preserves Commission, Natural Heritage Database, October 1991

A lack of funds to acquire land has limited the state's ability to preserve natural areas. Alternative approaches, such as acquiring easements and land donations, have met with limited success. To consolidate and add acreage to the Daniel Boone National Forest (DBNF), the U.S. Forest Service has used land trades. Since 1982, the U.S. Forest Service has approved trades involving 9,213 acres of land in the DBNF. Several of these trades have been controversial because they involved trading forestlands containing mineral deposits for previously mined lands.

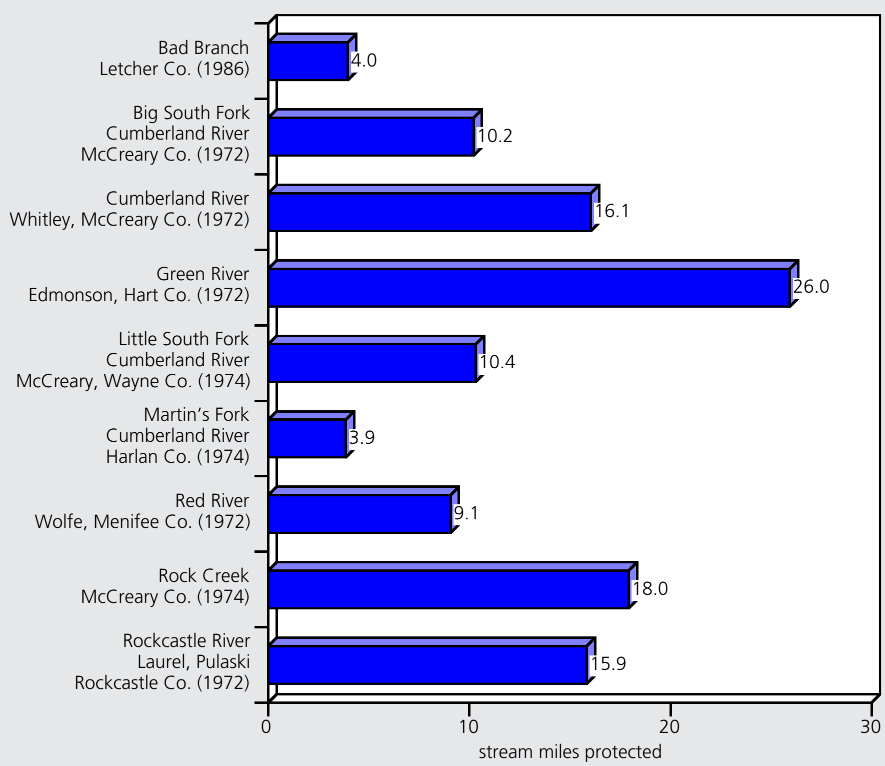
Efforts by some public interest groups to seek federal funds to support national forestland acquisition and minimize land trades in the DBNF resulted in a $5 million appropriation in 1990. Some 2,500 acres have since been purchased and added to the Daniel Boone National Forest. The U.S. Forest Service has identified an additional 17,300 acres near the DBNF, many of which contain critical habitat for threatened and endangered species, as suitable for purchase. The agency has also recently expressed interest in establishing a third wilderness area in the DBNF.

Wild Rivers

Nine State Wild Rivers Cover 113.6 Miles; Many Experiencing Water Quality Problems

The Kentucky Wild Rivers System was legislatively established to preserve the unique primitive character and environmental quality of some of the state's most outstanding natural streams. Since 1972, nine river segments have been designated as state "Wild Rivers" **(Fig. 49)**. Eight of the state's nine Wild Rivers were designated in the 1970s. The most recent addition occurred in 1986, with the inclusion of Bad Branch in Letcher County. Seven of these segments are located within the Cumberland River Basin in Southeastern Kentucky. Legislation, introduced in the 1992 General Assembly, to designate a portion of Tygarts Creek in Carter County was unsuccessful. Land use activities, such as logging and mining, are limited along the 113.6 miles of Wild River corridors.

Figure 49
State Wild River Segments



Source: Kentucky Division of Water, 1991

The Kentucky Wild Rivers system was established to preserve some of the state's most outstanding natural streams. Since 1972, nine river segments (113.6 miles) have been designated as Wild Rivers. Most of these streams are experiencing water quality problems.

Most of the state's Wild Rivers are experiencing water quality problems. The Little South Fork of the Cumberland River has been impacted by acid mine drainage at levels harmful to aquatic organisms. The Rockcastle, Red, and Cumberland rivers have been, and continue to be, impacted by nonpoint source runoff pollution from mining, forestry, and construction activities. Another concern regarding the state's Wild Rivers is the lack of adequate public access for canoeing and other recreational activities. There are only 18 public access points to all nine Wild River segments.

A statewide rivers assessment was conducted by the Division of Water during 1990 and 1991 to assist in identifying potential wild, scenic, and recreational rivers and streams. The assessment determined the following:

- Eight river segments covering 49 miles were considered superior waters. These segments have outstanding natural features of national or statewide significance such as cliffs, waterfalls, and unique vegetation or aquatic resources.
- Undeveloped or pristine river segments not afforded protection were generally being degraded.
- Three hundred miles of rivers and streams were classified as having recreational, scenic, and fishing qualities, or other values of regional significance.
- Eighteen river segments covering 318 miles were identified as having significant social and economic values to local communities.

It is important to note that this assessment only considered 12% of the state's rivers. Additional surveys and continued monitoring are needed to determine the condition and protection needs of many streams and rivers in the state.

Because of general resistance to land use controls, the designation of future state Wild Rivers appears unlikely. Additional categories for scenic or recreational rivers may be needed in Kentucky to provide various levels of protection that are not as stringent as Wild River provisions.

No National Wild and Scenic River in Kentucky; Upper Red River Awaiting Federal Action Since 1984

In addition to the state Wild Rivers program, Congress enacted the National Wild and Scenic River Act in 1968. None of the 123 federally–designated Wild and Scenic Rivers found in 33 states are located in Kentucky. The U.S. Forest Service is required to review the potential of nine rivers located within the boundaries of the Daniel Boone National Forest as candidates for national Wild and Scenic River designation. These rivers are:

- Upper Red River
- Lower Red River
- Cumberland River
- Rockcastle River
- Marsh Creek
- War Fork and South Fork of Station Camp Creek
- South Fork of the Kentucky River
- Little South Fork of the Cumberland River
- Rock Creek

The U.S. Forest Service has reviewed, or is in the process of reviewing, seven of these rivers. The agency will determine the suitability of these rivers as part of an Environmental Impact Statement to be completed in 1992. The agency did issue a 1984 report to the U.S. Department of Agriculture (USDA) on the suitability of the Upper Red River as a Wild and Scenic River. The USDA has yet to take action on the report. There appears to be a reluctance on the part of the national administration to release the report to Congress for their review and action. This may be due, in part, to the unresolved and controversial Red River dam proposal.

Outstanding Resource Waters

66 Unique Waterbodies Afforded Protection as Outstanding Resource Waters

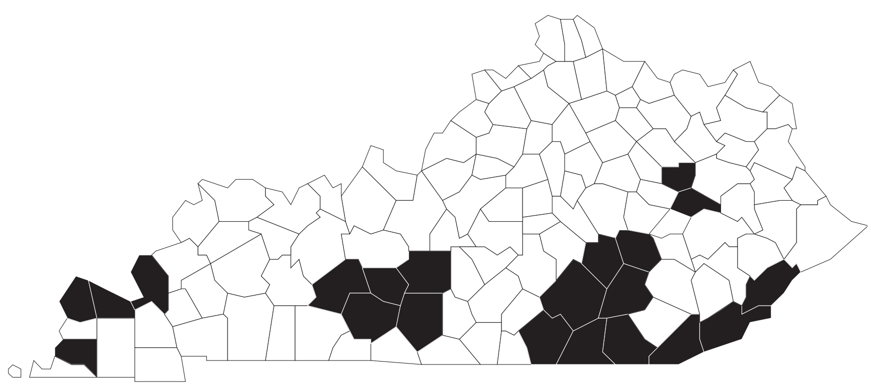
The nine state Wild Rivers, along with 57 other waterbodies in Kentucky, have been designated by the state as Outstanding Resource Waters (ORWs). These waters range in size from small streams to segments of large rivers. These 66 waterbodies support federally–protected threatened and endangered species or contain habitats supporting diverse and unique aquatic flora and fauna **(Fig. 50)**.

Industrial and municipal discharges to ORWs are controlled through state water discharge permits. A permittee must demonstrate that the lowering of water quality or modification of habitat will not have a harmful effect on a protected species. Special conditions are provided in state industrial and municipal water discharge permits to monitor the biological community and physiochemical properties of the waterbody. This is required to determine if more stringent or additional criteria are necessary to protect rare species or their habitat.

Some ORWs are experiencing water quality problems because of human disturbances such as coal mining operations, wastewater treatment facility discharges, and runoff from agricultural, forestry, and road construction activities. The Division of Water currently requires biological and physiochemical monitoring for discharges to ORWs from seven mining operations and one municipal wastewater treatment plant. All facilities that discharge to an ORW are evaluated on a case–by–case basis. A coal operation was recently ordered to cease activities after it was discovered to be impacting the habitat of the federally–protected blacksided dace, a rare fish occurring in the ORW into which the discharge was permitted. This situation indicates that greater state monitoring of permitted discharges to ORWs is needed to ensure impacts are minimized.

There are 66 waterbodies in 21 counties that have been designated as Outstanding Resource Waters. These streams support threatened or endangered species or diverse and unique aquatic habitats. Some ORWs are experiencing water quality problems.

Figure 50
Counties with Outstanding Resource Waters



Source: Kentucky Division of Water, 1991

Caves

Thousands of Caves Located in 87 Counties; Many Impacted by Pollution

One of Kentucky's most unique natural features is the widespread presence of caves. Approximately 50% of the state is underlain by cave–forming limestone. Groundwater dissolves rock surfaces forming large sinkholes, channels, and caves. These areas are commonly known as "karst" regions.

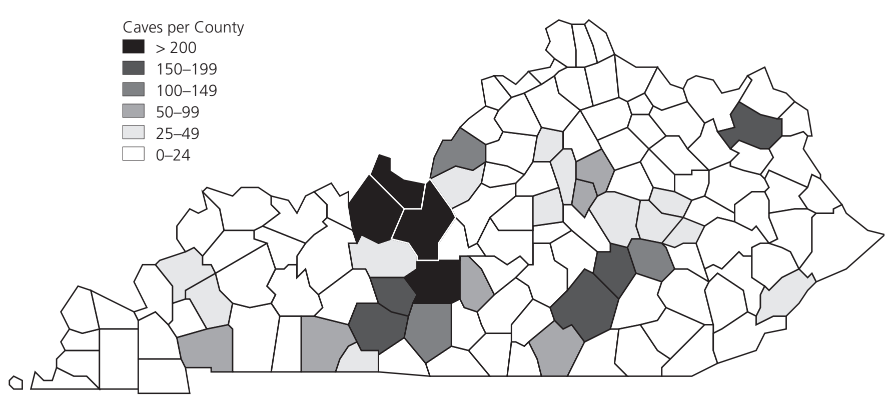
More than 4,000 caves have been discovered in 87 Kentucky counties **(Fig. 51)**. Many communities originally developed around caves and springs because of the access provided to water supplies. Caves have many important historical, economic, cultural, recreational, and ecological values. Mammoth Cave, the largest known cave system in the world, attracts 1.5 million visitors a year to Kentucky. These visitors spend $250 million annually while enjoying Mammoth Cave National Park located in Edmonson, Hart, and Barren counties.

Caves are extremely vulnerable to nearly every type of pollution. Sewage contamination has threatened Mammoth Cave to the extent it may be closed for health reasons. Efforts to build a regional sewage treatment system for the surrounding area have met with many delays. The first phase of the project was completed in 1989 and has succeeded in removing the primary source of pollution to caves in the area. Unfortunately, sewage has completely destroyed Hidden Rivers Cave in the city of Horse Cave in Hart County. The National Park Service initiated a three-year "Mammoth Cave Water Quality Program" in 1990 to further assess trends and pollution problems in the Green River Basin that potentially impact the park.

Caves in Kentucky provide habitat to more than 200 species of cave life. Fourteen percent of the federally–designated threatened and endangered species found in the state are dependent upon caves for their existence. These cave–dwelling species are at risk from competition with nonnative species, pollution, and development pressures. The native gray bat has decreased from a population of 515,000 in 1979, to only 200,000 in 1990. The Indiana bat, a federally–protected species found in Kentucky, is declining 7% each year due, in large part, to the loss and degradation of cave habitats.

One of Kentucky's unique natural features is the widespread presence of caves. More than 4,000 caves have been discovered in 87 counties. Many caves are impacted by pollution.

Figure 51
Caves of Kentucky



Source: American Cave Conservation Association, 1991

In 1988, the Federal Cave Resources Act was adopted by Congress to ensure that caves on federal lands with significant qualities such as archaeological artifacts, endangered species, and other features of public interest were properly managed to prevent degradation. Federal regulations to implement the act are still under development. Awareness of the importance of caves in Kentucky is also being fostered by the work of the American Cave Conservation Association located in Horse Cave, the National Park Service at Mammoth Cave, and Kentucky's Boone Karst Conservation Task Force. The task force works cooperatively with the U.S. Forest Service to survey caves in the Daniel Boone National Forest.

Wetlands

Many Rare Species Found in Wetlands; Loss of Wetlands May Cause Up to 80% More Floods

"Wetland" is a collective term used to describe a variety of ecosystems which include swamps, marshes, and other transitional zones that exist between open water and dry land. Wetlands occur where water is found at, or near, the ground surface, or in places where the ground is covered by shallow water ranging from a few inches to several feet deep. It is important to note that wetlands are not necessarily wet all year. Many, such as bottomland hardwood forests, are often dry during certain periods of the year. Therefore, the casual observer may not always be able to recognize or correctly identify wetlands.

In their natural conditions, wetlands offer many benefits. They provide habitat to a multitude of fish and wildlife species, many of which are endangered or threatened. Wetlands also provide erosion and flood control, water quality enhancement of streams and rivers, groundwater purification, natural products, and recreation. Wetlands are believed to contribute to climatic influences as well.

In the past, wetlands were often regarded as wastelands—simply sources of mosquitoes, flies, and unpleasant odors. Wetlands were viewed as useless land to be drained or filled for other purposes, such as agriculture and development. Lack of knowledge and appreciation of wetlands led to the destruction of most of Kentucky's original wetlands.

More recently, an increased understanding of ecological processes has changed attitudes about wetlands. People now better understand the valuable natural resources and benefits that wetlands provide. For example, approximately 45% of the animals and 26% of the plants that are federally–listed endangered or threatened species are dependent on wetlands during some portion of their life cycle. Another important function seldom considered is the ability of wetlands to reduce flooding. In watersheds where wetlands have been lost, flood peaks have been documented to increase by as much as 80%.

80% of State's Original Wetlands Have Been Destroyed, 360,000 Acres Remain; Wetland Maps Prepared for 60% of State

Originally, Kentucky had an estimated 1.6 million acres of wetlands. By 1977, approximately 929,000 acres (58%) of all the state's wetlands had been drained and converted to farmland and other uses. The greatest losses occurred in Western Kentucky where 52% of the state's bottomland forests were cleared between 1957 and 1974.

Today, an estimated 360,000 acres of wetlands remain, representing a total state loss of 80%. Only 20% of the state's remaining wetlands are forested. U.S. Fish and Wildlife experts indicate that 3,600 acres of wetlands continue to be lost every year in the state.

Most of Kentucky's remaining wetlands are privately owned. Only 26,000 acres are owned and managed by public agencies. The majority of wetlands are located in the Jackson Purchase and Western Coalfield regions, although all of the state's 120 counties have wetlands located within their borders to some degree.

A statewide project to identify and map wetlands is currently underway. Identification of wetlands through aerial photography and interpretation, and a review of soil maps is being conducted under the National Wetland Inventory (NWI) by the U.S. Fish and Wildlife Service.

The entire state has been mapped under the NWI, with approximately 60% of the maps in final form. The Natural Resources and Environmental Protection Cabinet is digitizing the maps in order to create a computerized wetland database. About 50% of the maps have been digitized with the remainder to be finalized by 1993. Once complete, there should be a much better understanding of the quantity, type, and location of wetlands. When used as a planning tool, this information can help developers and regulators identify wetlands and reduce or avoid potential wetland conflicts.

Degradation of Remaining Wetlands a Continuing Concern

Compounding the loss of 80% of Kentucky's wetlands is the fact that nearly all remaining wetlands have been altered and degraded by land use activities. In 1989, the Division of Water identified wetlands impacted by various pollutants. The study revealed the following about 80 Western Kentucky wetlands:

- Fifty–four wetlands (68%) may be potentially impacted by high sediment loadings from various land–use activities;
- Thirty–eight wetlands (48%) are threatened by toxic heavy metals associated with mining activities;
- Nineteen wetlands (24%) are at risk from acid mine drainage.

The study showed that pollutants from mining, oil extraction, logging, channelization, impoundments, and other activities are contributing to the degradation of wetlands. Additionally, wetlands continue to be filled for agricultural and other uses.

No Specific National or State Wetland Protection Program; Piecemeal Efforts Have Limited Effect

There is currently no comprehensive national or state program designed to specifically protect wetlands. Most wetland protection initiatives are provided through various piecemeal federal and state programs. The U.S. Corps of Engineers is responsible for issuing Clean Water Act Section 404 permits which regulate dredge and fill activities in wetlands. Since 1983, the Corps has issued an average 130 permits per year in Kentucky for dredge and fill activities, many of which include wetlands. During this period, there is no record that the Corps has denied any application to fill a Kentucky wetland.

The Division of Water, under Section 401 of the Clean Water Act, is responsible for ensuring that applicable water quality standards will not be violated by dredge and fill activities. Because state regulations do not contain specific wetland protection provisions, Section 401 does not typically provide a means to protect this type of water resource. At best, the Division issues approval of the activity through a conditional water quality certification in an attempt to offset some of the wetland loss.

The "Swampbuster" provisions of the federal Food, Agriculture, Conservation, and Trade Act of 1990 addresses wetlands to some degree. Federal farm program benefits can be denied to any person who converts a wetland by draining, dredging, filling, and/or leveling after December 23, 1985, under the Swampbuster provisions of the act. Wetlands converted to agricultural use before that date are exempt from the Swampbuster provisions. Some contend that the Swampbuster program is flawed and poorly implemented in much of the nation, including Kentucky. Problems arise in conflicting wetland determinations, interpretations of the provisions of the program, definitions of "conversion," and enforcement. Another notable weakness of the program is that only 58% of Kentucky's agricultural base acreage is enrolled in federal farm subsidy programs subject to these provisions.

The Kentucky Department of Surface Mining Reclamation and Enforcement (DSMRE) is required to ensure wetland impacts are minimized from coal mining activities and properly permitted. Concerns that the agency was not conducting adequate wetland reviews were verified in 1986 when the U.S. Corps of Engineers closed a state–permitted coal mining operation in Hopkins County after it was discovered to be mining a 500–acre wetland without a Section 404 dredge and fill permit. The federal government has subsequently issued a conditional permit to mine the wetland, although the company will be required to restore the wetland once mining is complete. The company will also purchase an additional 746 acres of land off–site, a portion of which will be restored to wetlands and deeded to the state as part of its wetland mitigation plan. It is not known how many wetlands have been lost in the past due to mining. DSMRE has recently improved its efforts to identify wetlands prior to the issuance of mining permits. Wetland maps and greater cooperation and consultation among state agencies should also assist in this effort.

Wetland Protection Debated at State and National Levels; Change in Definition May Affect 70% of Remaining Wetlands in Kentucky

The protection of wetlands has been extensively debated, both at the state and national levels. The debate has focused on the definition of wetlands, as well as mitigation and restoration requirements. The existing 1989 federal definition covers an estimated 200 million acres of wetlands nationwide. The Bush Administration has proposed a revised definition which would dramatically reduce the acres of wetlands protected under the Clean Water Act. The national administration has proposed that in order to qualify as a wetland, an area must have a minimum of 15 consecutive days of surface inundation, or 21 consecutive days of soil saturation to the surface between mid–April through October. Strict proof that such hydrologic conditions exist would need to be demonstrated.

The U.S. Soil Conservation Service estimates that under these proposed requirements, only the ponded phases of hydric soils would qualify, resulting in a loss of protection for approximately 70% of the wetlands occurring in Kentucky. The U.S. Fish and Wildlife Service estimates the loss could be closer to 90%. Understandably, these are controversial proposals, the outcome of which will not be known for several months after the comment period deadline.

The Bush Administration and Congress are also considering proposals to alter Section 404 dredge and fill provisions of the Clean Water Act. These proposals include the removal of U.S. Environmental Protection Agency from the dredge and fill permit review process, a shortened permitting procedure, reduced regulatory review, reduced lists of wetland plants and soils for determining regulated wetlands, removing "degraded" wetlands from protection, and declaring an automatic regulatory "taking" of private property whenever a permit is denied to alter a wetland, for which the landowner must be compensated. A bill, filed in the 1992 Kentucky General Assembly, also required compensation to landowners who could not fill their wetlands. The bill died in committee.

Protecting Kentucky's remaining wetlands is a complex task that will require a comprehensive statewide effort to preserve unique wetlands and develop a policy that is both effective and equitable. The Environmental Quality Commission formed a wetland task force in 1987. The task force recommended that a state wetlands protection program should include a balance of education, incentives, acquisition, and regulation. Such a program is critical for the future of these important natural resources.◆

Fish and Wildlife Resources

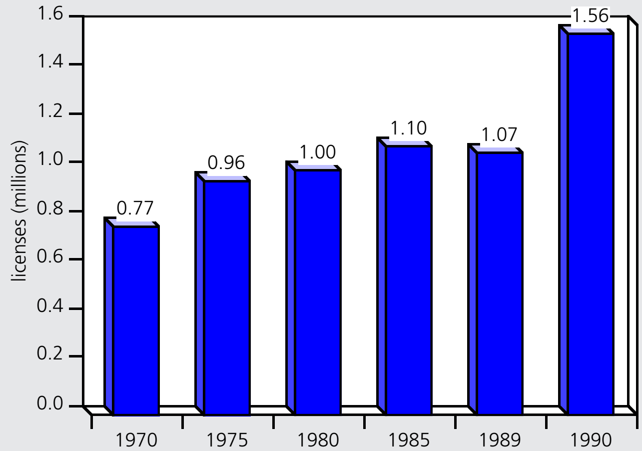
Kentucky's fish and wildlife resources greatly contribute to biological diversity, recreational needs, the economy, and the state's natural environment. The number of hunting and fishing licenses issued in Kentucky indicates that the Commonwealth continues to be a popular state for these activities **(Fig. 52)**. During 1990, fish and wildlife related activities alone generated over $900 million in sales. In addition, national trends show that wildlife photography and bird watching are among the fastest growing leisure–time activities in America. These and other nonconsumptive uses of wildlife contribute approximately $81 million in revenue to the state's economy each year.

Fish and wildlife populations can fluctuate from year–to–year because of natural and human disturbances. Alteration and destruction of habitat by pollution and human modification are the major factors impacting most of the state's fish and wildlife resources. Nature also affects populations through the forces of climate, disease, and predation. These factors combine to create an increasing challenge to maintain a balanced and diverse population of fish, mussels, birds, mammals, amphibians, and many other species important to Kentucky's natural heritage.

This section provides a general assessment of fish and wildlife populations occurring in Kentucky and the threats to these resources. Recognizing the need for more complete and accurate information, the Kentucky Department of Fish and Wildlife Resources recently committed to the development of a database to better access fish and wildlife information. Such a system would prove to be a valuable tool for determining protection and management needs in the state.

Picture of people fishing

Figure 52
Hunting and Fishing Licenses Sold in Kentucky



Source: Kentucky Department of Fish and Wildlife Resources, 1992

In 1990, hunting and fishing contributed an estimated $1 billion to the state's economy. Hunting and fishing license sales indicate that Kentucky continues to be popular for this past–time.

Fish and Mussels

Pollution Has Impacted Fish Populations; Toxics Lead to the Posting of Four Fish Consumption Advisories

More than 89,000 miles of streams and rivers, 360,000 acres of wetlands, and hundreds of public and private lakes provide habitat to the state's highly diverse array of fish and other aquatic resources. Kentucky is ranked third in the nation for the number of native fish and mussel species found within its borders and, along with some other areas of the Southeastern U.S., is considered to have a more diverse fish fauna than any other temperate region of the world. According to the Kentucky Department of Fish and Wildlife Resources (KDFWR), the Ohio River drainage basin contains 85% of the 242 species of fish found in the state, followed by the Cumberland River (65%), and the Green River (62%).

Aquatic habitat in Kentucky has been altered significantly by channelization, impoundments, and other modifications. These physical changes have affected the populations of many fish species. In a number of streams, pollution and siltation have impacted the health and diversity of fish populations. Twenty percent of the 9,184 miles of streams and rivers assessed by the Kentucky Division of Water (DOW) in 1991 could not support, or only partially supported, fish populations. In the Ohio River, 43% of the river miles bordering Kentucky cannot meet the nation's fishable goals, although fish population studies show improving conditions. More than 1.6 million fish were reported to have been killed due to pollution incidents during the past twelve years in Kentucky.

The impacts of water pollution on fish are evident statewide. Contamination and unhealthy fish populations impact both the state's sport fishing and its $4 million commercial fishing industry. A survey of anglers conducted by KDFWR, revealed that 44% believe the quality of fishing has declined during the past five years. Four waterbodies have been so impacted by pollution that fish consumption advisories have been issued. A fish consumption advisory was issued in 1989 for the entire stretch of the Ohio River bordering Kentucky after toxic PCB and chlordane contamination was discovered in catfish and white bass. Fish consumption advisories are also in effect for the Town Branch of the Mud River, Drakes Creek, and Little Bayou Creek.

28% of Kentuckians Fish; 6.8 Million Sport Fish Stocked in 85 Counties

Fishing is enjoyed by 28% of the state's population, according to KDFWR surveys. Fishery resources attract many people from out–of–state as well. Non–resident fishing license sales increased 47% during the past 11 years. Expenditures attributed to fishing in Kentucky are estimated at $394 million annually.

Commercial fishing has placed additional demands on this resource. State commercial license sales increased 42% between 1977 and 1987. The most popular commercial fishery resources in Kentucky include the Tennessee, the Cumberland (including Lake Barkley), and the Ohio rivers. Demands for commercial and sport fishing continue to increase. To meet this growing need, KDFWR manages fishery resources in the state and works to promote their protection.

There are approximately 14,000 miles of streams that contain important fishery resources. These include 51 streams totalling approximately 231 miles which KDFWR stocks with trout. Only ten of the state's 51 trout streams are considered high quality. These outstanding trout streams are located within the state's national parks and the Daniel Boone National Forest, where they are afforded protection.

Each year, KDFWR stocks various streams with fish including rainbow trout, walleye, striped bass, muskellunge, largemouth bass, smallmouth bass, and sauger. In 1990, 6.8 million fish were stocked in 66 streams and 11 public lakes in 85 counties. This is a slight increase from 1979 when 6.3 million fish were stocked. These efforts have assisted in restoring some fish species to streams where populations had been reduced due to pollution or habitat alteration. KDFWR also manages fish in 23 major reservoirs, 37 public lakes, and 50,000 private farm ponds.

Many Nongame Fish Species Impacted by Pollution, Disturbance; Protection and Enhancement of Streams Needed

Nongame fish species have also been impacted by habitat disturbance and pollution. These losses have both economic and ecological consequences. Sedimentation from strip mines has resulted in the decline of the arrow darter, blacksided dace, and the johnny darter—all small fish once commonly found in Kentucky streams. Acid mine drainage has affected the spotted sunfish and other fish species found in coalfield streams. Channelization and dredging have resulted in the decline of the cypress minnow and dollar sunfish. Impoundments have led to decreasing populations of lake sturgeon, paddlefish, and blue sucker. The lake sturgeon, yellow bass, sauger, and walleye have also been impacted by water quality and habitat degradation.

Habitat alteration and degradation are the primary reasons for the decline of fish populations throughout the state. Since some of the degradation is chronic, certain fish will remain depleted. According to KDFWR, preserving aquatic resources will be highly dependent on the following:

- The protection and enhancement of stream habitat;
- Establishment and maintenance of vegetative buffer zones along streams; and
- Greater efforts to control water pollution and promote watershed management.

Mussel Populations Decreasing Statewide; Loss of Habitat and Pollution Major Causes

Freshwater mussels are probably the most endangered group of organisms in Kentucky. The state's rivers and streams once supported large and diverse populations of mussels. Kentucky was once ranked third among all states for the number of mussel species. The combined effect of pollution, siltation, and impoundment of most large rivers during the past two centuries has resulted in the widespread decline of the state's native mussel fauna. Fourteen percent of the 103 mussels once found in the state are now extinct and another 39 are listed as rare and of special concern. Twenty–six percent of these species are either listed as federally–endangered or are candidates for listing.

The most recent threat to the state's mussel fauna is the substantial increase in the commercial harvest of their shells for use in the cultured pearl industry. During the past decade, the commercial harvest of mussels from state waterways has developed into a multi–million dollar industry. The species and rate of harvesting are unknown since there are no state reporting requirements to measure or monitor these activities.

A state license, issued by KDFWR, is required to commercially harvest mussels. Currently, there are 723 licenses in effect. Some areas in the state, such as designated mussel sanctuaries and areas 200 feet below dams and streams, are off–limits to musseling. In addition, minimum size limits are specified for some commercially harvested mussels. Some experts maintain that mortality of returned undersized mussels may contribute to population disruptions in the state.

Zebra mussels, on the other hand, are a potential threat to Kentucky waterways. This exotic mussel has invaded the Great Lakes causing millions of dollars in damage to power plants and the sport fishing industry. Small populations of zebra mussels have recently been discovered in Kentucky Lake and the Ohio River.

Preservation of the state's remaining native freshwater mussel fauna is dependent upon the successful maintenance of water quality and the control of siltation in streams, rivers, and lakes. Measures are also needed to monitor mussel harvesting activities and protect watersheds harboring both commercially important and endangered and threatened species.

Birds

52% of Kentucky's Bird Species Surveyed Decline in Number During the Past Decade; Duck Populations Decrease 50%

Forty percent of the 129 nesting bird species surveyed in Kentucky are decreasing in number, according to the U.S. Fish and Wildlife Service (USFWS) Survey of Breeding Birds for 1966–1990. This decline was even greater during the last decade when 52% of the 116 bird species surveyed showed decreasing populations **(Fig. 53)**.

The most important factor impacting bird populations is loss or alteration of habitat. The loss of brushy habitat, for example, is suspected to be contributing to the decline of field sparrows. Many species found in the forest interior have declined due to the clearing

Figure 53
Change in Kentucky Bird Populations, 1980–89

Species Increasing	% change	Species Decreasing	% change
Cattle Egret	+11.2	Little Blue Heron	–13.4
Cooper's Hawk	+6.1	Green–backed Heron	–5.2
Red–tailed Hawk	+5.2	Black Vulture	–8.7
Wild Turkey	+8.3	Sharp–shinned Hawk	–5.5
Pileated Woodpecker	+5.2	Rock Dove	–5.7
Eastern Phoebe	+5.4	Barred Owl	–5.2
Tree Swallow	+49.8	Gray Catbird	–9.3
Fish Crow	+19.0	Loggerhead Shrike	–8.6
Tufted Titmouse	+5.0	Blue–winged Warbler	–6.0
Carolina Wren	+23.4	Black–throated Green Warbler	–22.7
Eastern Bluebird	+10.6	American Red Start	–33.9
Cedar Waxwing	+20.5	Common Yellowthroat	–5.4
Blue Grosbeak	+10.1	Field Sparrow	–5.1
Song Sparrow	+5.1	Lark Sparrow	–5.4
House Finch	+25.2	Bobolink	–13.7
		Red–winged Blackbird	–5.0

Note: Selected species with at least a 5% change

Source: U. S. Fish and Wildlife Service Breeding Bird Survey, Kentucky 1990

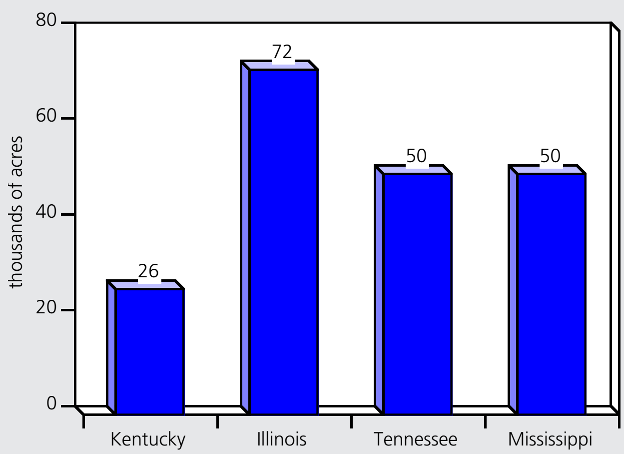
The U. S. Fish and Wildlife Service breeding bird survey for 1980–1990 indicates that 52% of the 116 species surveyed in Kentucky were declining in number.

and fragmentation of remaining forests. Some pesticides, such as DDT, are also believed to be responsible for the decline of many bird species including herons, egrets, ospreys, and eagles. Several species have been recovering slowly in Kentucky since DDT was banned in 1972. Increased protection measures and restoration programs are also contributing to the recovery of some bird species. Osprey restoration programs conducted on several lakes and rivers in Kentucky between 1982 and 1990 have resulted in six nests and 13 young.

Declines in some bird populations are partially explained by introduction of non–native species which have overtaken the ranges of native birds. For example, the decline of the eastern bluebird and other cavity–nesting birds is attributed to competition with the European starling which was introduced in the 1900s.

Duck populations have decreased nationwide by approximately 50% since 1959. This trend is reflected in Kentucky's wintering populations as well. State inventories revealed that average duck populations were 70,000 in 1959, compared to 25,000 in 1990. The major reason for the decrease of waterfowl populations is the loss of wetlands in Canadian and U.S. breeding grounds, as well as in the more southerly wetland wintering areas. Kentucky lags well behind its neighboring states in protecting and managing wetlands for waterfowl **(Fig. 54)**.

Figure 54
State Comparison of Wetlands Managed for Waterfowl



Source: Kentucky Department of Fish and Wildlife Resources, 1991

The Kentucky Department of Fish and Wildlife Resources indicates that Kentucky lags well behind its neighboring states in protecting and managing wetlands for waterfowl habitat. State inventories reveal that average daily duck populations were 25,000 in 1990 compared to 70,000 in 1959.

Wild Turkey Population Estimated at 25,000; Grouse Being Restored

Although wild turkeys were abundant throughout the Commonwealth in pioneer times, by 1946, the only known population was in the Kentucky Woodlands National Wildlife Refuge, now known as Land Between the Lakes. State restoration efforts for the wild turkey began in 1978. Since then, 3,697 birds have been released at 225 sites across the state. Statewide wild turkey populations are now estimated at 25,000. These birds are found in 118 counties, although most local populations are at low levels. Only about 25% of wild turkey habitat is currently occupied by viable populations.

Ruffed grouse were once found statewide. As with many species, land use changes and unregulated hunting during the 1800s and early 1900s virtually eliminated the bird from the western area of the state. Grouse are now limited to the more rugged terrain of

Eastern and Central Kentucky where the land is not generally suitable for agriculture. The status and population trends of grouse are not well known, however, KDFWR surveys are underway to assess current populations. Grouse populations are believed to be on the upswing due to the creation of additional grouse habitat from abandoned marginal farmland and the maturing of forests. KDFWR has a program to restore grouse in Central and Western Kentucky.

Bobwhite Rebound From Severe Winters; American Woodcock Declining

Bobwhite, a small popular game bird, is found throughout the state where a mix of croplands, grasslands, brushy habitats, and woodlands are located within proximity of one another. Bobwhite are most abundant in the western portion of the state. Short–term population fluctuations are primarily caused by the weather. The severe winter of 1977–78 impacted the bobwhite population in Kentucky dramatically, and it is still recovering.

Loss of habitat has impacted quail populations, particularly in Western Kentucky. The long–term population trends for quail show a decline.

The American woodcock is found in forest areas where vegetation is less than 30 years old. There is no state data on the American woodcock, however, the USFWS indicates that populations have declined 30% in the Eastern, and 10% in the Central regions of the U.S. The loss of forest habitat and the use of pesticides have impacted woodcock populations.

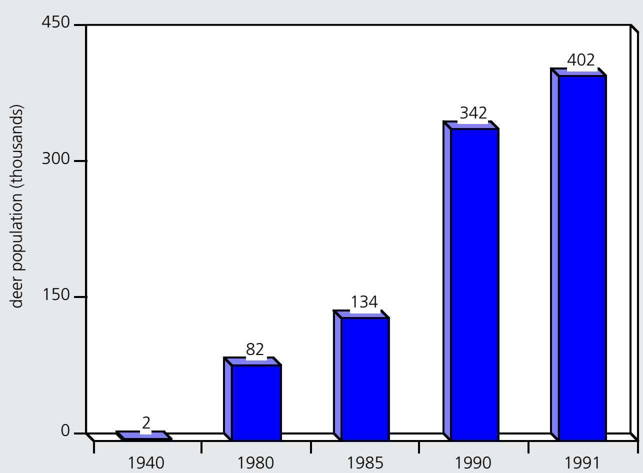
Deer and Other Mammals

Deer Herds Once Reduced to 2,000, Expand to Near 402,000 Statewide

Deer populations in Kentucky have risen dramatically since 1940 when unregulated hunting reduced their numbers to 2,000 **(Fig. 55)**. Today, herd populations are approaching 402,000 statewide. Restocking efforts in the 1950s and 1960s greatly contributed to their recovery. Herds in Western Kentucky are considered stable and those in eastern regions of the state are still growing. Statewide, herds are expected to be fully stabilized by the year 2000. Illegal poaching and free–roaming dogs, however, continue to inhibit deer in some areas of the state. KDFWR is still stocking a few Eastern Kentucky counties with deer to increase herds.

Figure 55

Deer Population in Kentucky



Source: Kentucky Department of Fish and Wildlife Resources, 1991

Deer herds in Kentucky have increased dramatically since 1940 when unregulated hunting reduced their numbers to 2,000. Herds are expected to be fully stabilized by the year 2000.

Coyote Found in Almost All Counties; Bobcat and Bear Returning to Kentucky

Coyote began to appear in Kentucky during the 1960s and are now found in every county. The state's coyote population is increasing slowly. Bobcat, despite the loss of mature forests which provide their habitat, still roam the wilder areas of the state. Bobcat are found across the state except in some Bluegrass and Central Kentucky counties. In 1987, the bobcat population was considered stable enough that KDFWR reopened a limited hunting season, which had been closed since 1973.

Wolf populations were eliminated from the state well before the turn of the century, falling victim to human encroachment. A recent federal proposal to reintroduce the red wolf at Land Between the Lakes received negative public reaction and has not been undertaken. While sightings of eastern cougar are regularly reported, no firm evidence of this wild animal has been documented in Kentucky during the past century.

Populations of the native black bear have also declined significantly since the state was settled as a result of unregulated hunting and the loss of large tracts of forests needed for their habitat. Bear are slowly returning to the state, especially to the Cumberland Plateau area of Eastern Kentucky. Their return is primarily due to the regrowth and maturing of forests and protection from illegal hunting. Perhaps the most important factor has been the expansion of bear populations in the neighboring states of West Virginia, Virginia, and Tennessee, and their subsequent movement into Kentucky.

Beaver and River Otter Once Nearly Extinct in Kentucky Increasing in Numbers

The wild furbearers of Kentucky are an ecologically diverse collection of species. Raccoon, mink, opossum, muskrat, red fox, gray fox, and striped skunk are found in every county. Despite the lower populations of raccoons in the eastern Cumberland Plateau counties, these species are considered abundant in Kentucky and populations are increasing.

Once nearly extinct from the state, beaver and river otter are increasing in numbers and their range is expanding. Pursuit of the beaver and otter for fur led to their near extinction in the 1900s. Beaver are now found in most Kentucky counties west of the Cumberland Plateau. According to KDFWR, damage caused by beaver populations is a concern in Western Kentucky. Isolated populations of beaver also occur in water reservoirs located in the extreme eastern counties of the state. Movement of beaver from these reservoirs is expected to restore this species statewide. River otter are now reestablished in ten to 15 Western Kentucky counties. KDFWR restoration programs in Spencer, Harrison, and Grant counties in 1991, and future programs in Central and Eastern Kentucky, should establish river otter statewide.

Some species of the wild furbearer group including the weasel, badger, skunk, and particularly the mink, are very sensitive to environmental degradation. Studies have linked reproductive failures in mink to the bioaccumulation of pesticides and PCBs in their tissue. While mink populations in nearby states are declining due to pollutants, Kentucky populations appear to be stable.

The longtailed weasel is believed to occur statewide. The least weasel and the spotted skunk, however, are considered rare and limited to only a few counties in Kentucky. The striped skunk is more abundant and can be found in urban areas and counties with small tracts of agricultural land. They are least abundant in areas of unbroken forests. The badger is a relatively new species sometimes reported in Kentucky, but no breeding populations have been established.

Reduced harvests are resulting in increased furbearer populations in the state. The raccoon is the most pursued furbearer species in Kentucky. Between 1983 and 1988, an average 68,000 raccoon were trapped each year in the state. Muskrat, opossum, red and gray fox, mink, beaver, coyote, striped skunk, and weasel are also currently harvested for fur. Dramatic declines in the number of animals trapped in the state have occurred since 1979. If the demand for fur products continues to decline as predicted, the reduced harvest will likely increase populations of these species.

Rabbit and Red Squirrel Populations Reduced; Rare New England Cottontail Found on Black Mountain in Harlan County

Eastern cottontail rabbit occur statewide, in both rural and urban settings. The largest rabbit populations are found in active agricultural lands or reverting farmlands in the state's Pennyroyal Region and in the hills of the Bluegrass. KDFWR data suggest that there has been a decline in rabbit populations during the last 20 years. Current populations are 30% below the long–term yearly average. It is not known if this decline is due to cyclic trends or loss of the high–quality habitat. Rabbit populations will likely increase in Kentucky unless severe winters adversely affect their populations.

Some rabbit species, such as the swamp rabbit and the New England cottontail, have limited ranges in the state. The swamp rabbit is found only in 15 Western Kentucky counties. The number of these rabbits has been drastically reduced and fragmented due to the loss of bottomland forests. The New England cottontail has declined throughout much of its Northern U.S. range due to competition with the eastern cottontail. The distribution of these rabbits in Kentucky is not known, however, the species was documented on Big Black Mountain in Harlan County in the 1950s. Experts believe that populations of the New England cottontail in the southern range, such as Kentucky, will play an important role in its continued existence.

Human use of land has also affected squirrel populations. Squirrel are dependent on forests for both habitat and food. The clearing of forests for housing, mining, and other uses has affected squirrel populations throughout the state. With steady increases in forestland, gray squirrel habitat and populations are increasing, according to KDFWR. Fox squirrel habitat, however, has been fragmented and destroyed during the last three decades, significantly impacting populations.

90% of Vertebrate Animals are Nongame Species; Funding to Protect and Manage Has Been Limited

Of the 762 species of vertebrate animals known in Kentucky, at least 695, or more than 90%, are regarded as nongame wildlife **(Fig. 56)**. Nongame species in the state comprise 85% of all fish, amphibians, and reptiles, 93% of all birds, and 92% of all mammals.

Funding for nongame species management and protection in Kentucky has been limited. In the past, most state funds for nongame programs have been generated through the Kentucky Income Tax Nongame Wildlife/Natural Areas checkoff program. This voluntary program has generated an average $83,000 annually for the past ten years. These funds, split equally between KDFWR and the Kentucky Nature Preserves Commission (NPC), are used for research and management of nongame species. KDFWR also commits some funds received through federal grants and license revenues to the nongame species program **(Fig. 57)**. Currently, three KDFWR staff are assigned full–time to this program and many of their staff of 300 participate in nongame–related research and management work. Nongame wildlife also benefit from the management of state and private lands for game species, according to KDFWR.

Figure 56

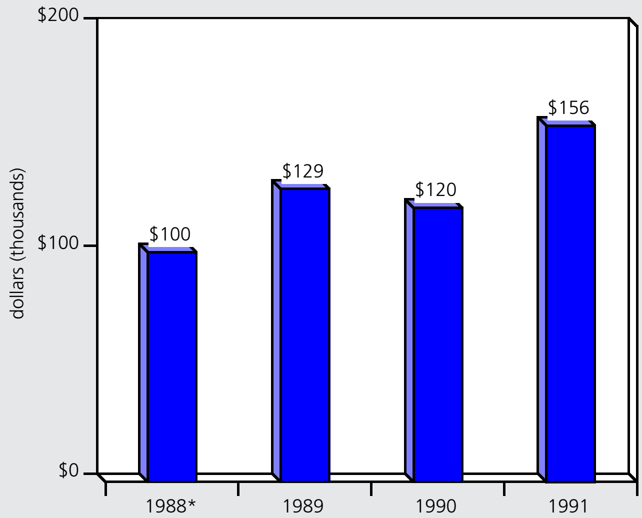
Game and Nongame Species in Kentucky

	Fish	Amphibians/ Reptiles	Birds	Mammals
Game	36	0	24	6
Non–game	200	105	316	60
Total	**242**	**105**	**340**	**75**

Source: Kentucky State Nature Preserves Commission, 1991

Of approximately 762 species of vertebrate animals in Kentucky, more than 90% are considered nongame wildlife. According to some experts, nongame species populations are declining statewide.

Figure 57
Kentucky Department of Fish and Wildlife Resources Nongame Program Funding



**earlier data unavailable*

Source: Kentucky Department of Fish and Wildlife Resources, 1991

State funding to protect and manage nongame species has been limited. Some efforts have been made to allocate additional resources to state nongame programs.

The Nature Preserves Commission has assisted in providing nongame habitat through its 24 nature preserves. Two NPC staff are dedicated to nongame animal species research and protection projects. Moreover, NPC in cooperation with biologists, state and federal agencies, academicians, and others maintains the Natural Heritage Database. The database is a computerized inventory of all the state's rare plants and animals, most of which are nongame species. The Natural Heritage Database is continually updated to provide current information for environmental assessments, as well as management decisions and protection priorities regarding rare species. Federal agencies, such as the U.S. Forest Service and Tennessee Valley Authority, also actively participate in nongame wildlife conservation through the management of large parcels of land in Kentucky.

Nongame Species Not Surveyed Regularly; Assessing Trends Difficult

Currently, most nongame species are not surveyed regularly so assessing trends is not possible. According to some experts, nongame species populations in Kentucky are declining statewide, although some species appear to be relatively stable and others are actually increasing. In general, the fauna seen today are products of tremendous human alteration of the landscape. During the last two centuries, vast areas of mature forest, prairie, and savanna were converted to settlements and agricultural land. Most of the state's larger rivers have been impounded or degraded with pollution and siltation.

At the time of settlement, each of Kentucky's varying habitats had a wildlife fauna that included species no longer found in the state. Eastern cougar are gone from forests; prairie–chicken, like much of the prairies they inhabited, disappeared more than a century ago; bison and the natural savannas of the Bluegrass are gone; Ivory–billed woodpecker have not inhabited Western Kentucky swamps in over a hundred years; and more than a dozen species of freshwater mussels have become extinct.

Many species that were once widespread and abundant are now restricted in range or have disappeared from Kentucky. In contrast, several of the nongame animals regarded as abundant today, were probably difficult to find in Kentucky before settlement. Many of the state's original species have been replaced by others that have been able to adapt to the state's changing landscape.

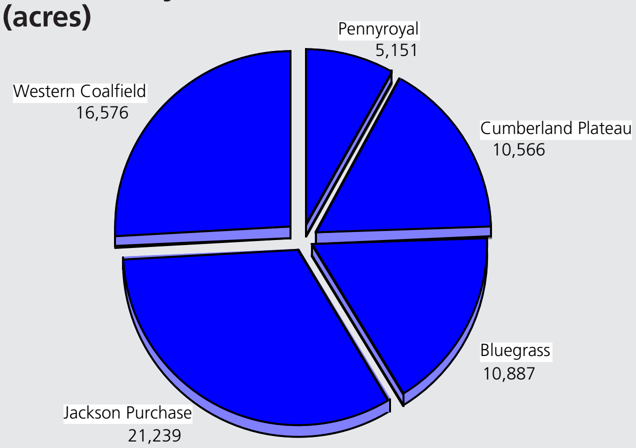
The most significant threat to native nongame species is further alteration or destruction of their habitat. Until optimum or preferred habitat is adequately protected, many nongame species will decline in number. Continued scientific research on nongame species, support of habitat restoration, and protection projects are essential if Kentucky is to maintain diverse and abundant wildlife populations.

Wildlife Management

61 Wildlife Management Areas Located in 72 Kentucky Counties

KDFWR was given the statutory authority to protect and conserve wildlife for present and future generations. To achieve this goal, KDFWR has purchased 64,419 acres of land during the past 45 years which are managed as 25 wildlife management areas **(Fig. 58)**. KDFWR also manages 36 additional wildlife management areas consisting of approximately 634,000 acres. This includes 292,053 federally–owned acres under long–term lease to KDFWR for management or monitoring. This federal land consists of portions of the Daniel Boone National Forest and water reservoir areas. Lands are managed to provide for the well-being of wildlife resources and the prudent harvesting of animals.

Figure 58
State Wildlife Management Areas in Kentucky (acres)



Source: Kentucky Department of Fish and Wildlife Resources, 1991

During the past 45 years, the Kentucky Department of Fish and Wildlife Resources has purchased 64,419 acres of land which are managed as 25 state wildlife management areas.

KDFWR expends a major portion of its $16 million annual budget managing these lands, located in 72 counties, for wildlife habitat and recreation. State wildlife management areas were purchased through federal grants and hunting and fishing license sales. These funds are also used for fish restoration and general enforcement activities. In addition, the sale of Kentucky waterfowl stamps, required for duck hunting, have generated $400,000 since 1985. These funds have helped purchase 26,000 acres of wetlands and manage an additional 14,000 acres of private and federal wetlands for waterfowl habitat.

Major initiatives to create and protect wildlife habitat on private lands have been developed through the cooperative efforts of many state and federal agencies. The North American Waterfowl Management Plan, the North American Wetlands Conservation Act, the Forest Stewardship Act, the 1990 Farm Bill, and Kentucky's Habitat Improvement Program all have components which promote habitat development on private land. These initiatives are particularly important since almost 95% of the land in Kentucky is privately owned.

Efforts to protect Kentucky's wildlife also include the enforcement of state hunting, fishing, and trapping laws and regulations. During 1991, 6,579 citations were issued by KDFWR's 137 enforcement officers and $271,800 in fines were collected, compared to $78,900 in penalties during 1981. Fines are allocated back to KDFWR's Fish and Game Fund and the agency's General Fund.◆

Picture of bald eagle

Threatened and Endangered Species

More than 500 animal and plant species and subspecies are believed to have become extinct in the U.S. since Columbus first came to the New World 500 years ago. Extinctions are occurring at such a rate that the U.S. Environmental Protection Agency has cited the loss of biodiversity as one of the greatest ecological threats facing the world today. For example, it is estimated that from 25% to 60% of the world's rainforests, the most diverse ecosystems in the world, have already been lost, while another 42 million acres are deforested annually. According to the National Science Foundation, the loss of global biodiversity could have significant impacts. The rate of extinction worldwide over the next few decades could rise to 1,000 times the normal historic rate. This could result in the loss of half the species on earth.

The natural quality and biodiversity of Kentucky's land, water, aquatic, and terrestrial resources also are being threatened by development pressures and environmental degradation. Animal and plant populations contribute recreational values and are a source of medicine. Most importantly, they are indicators of the ecological health of the environment. This section reviews the status of Kentucky's threatened and endangered species and efforts underway to protect them.

330 Plant and 224 Animal Species or Subspecies in Kentucky are Considered Threatened, Endangered, or of Special Concern; Only 25 Afforded Federal Protection

The rate of species extinction in the U.S. is considered unnaturally high and promises to accelerate rapidly. This is primarily due to loss of habitat and environmental degradation. A recent 50–state inventory suggests 9,000 plant and animal species may be currently at risk. The President's Council on Environmental Quality reports that experts estimate 700 plants may face extinction within the next decade.

The impact of species extinction can be seen more fully when compared to the number of species that occur in Kentucky. For example, of the state's 103 mussel species, 37% are considered threatened, endangered, extinct, or of special concern, according to the Kentucky Nature Preserves Commission (NPC). In addition, 30% of the state's 230 native fish species are of special concern and 21% of the state's 75 native mammal species are considered rare by some experts **(Fig. 59)**.

To protect species in danger of extinction, Congress passed the Endangered Species Act in 1973. Federal law presently offers protection to 600 federally–listed plant and animal species. There are 19 animal and six plant species in Kentucky that are currently afforded protection under federal law. In addition, Environmental Assessments, and in some cases, Environmental Impact Statements, must be prepared for activities occurring on federal lands, or for projects involving federal funds. These are required to assess and minimize impacts to the environment, as well as to threatened and endangered plants and animals.

Another 4,000 potentially threatened and endangered species currently await consideration for federal listing. At least 95 of these species occur in Kentucky. It often takes years to list a threatened or endangered species at the federal level. During the last decade, at least 34 species or subspecies have become extinct in the U.S. while pending review. The federal list only includes nationally threatened or endangered species and does not consider species threatened with local or state extinction.

Figure 59
Status of Kentucky's Plants and Animals (selected groups)

	Vascular Plants	Fish	Mussels	Amphibians & Reptiles	Birds	Mammals
Number of Species in Kentucky	3,000	242	103	105	340	75
Number Federally Threatened or Endangered	6	2	11	0	3	3
Number Proposed as Federally Threatened or Endangered	31	10	14	4	4	6
Number of Species Presumed Extinct or Extirpated out of Ky.	0	2	15	1	3	5
Number of Species of State Concern	330	70	39	38	45	16
% of Kentucky Species Considered Rare	**11%**	**30%**	**37%**	**27%**	**13%**	**21%**

Source: Kentucky State Nature Preserves Commission, 1991

The impact of species extinction in Kentucky can be seen more fully when compared to the number of species that occur in the state. For example, almost 37% of the state's mussel species and 21% of the 75 mammals in Kentucky are considered rare.

NPC estimates that 330 plants and 224 animals in Kentucky are threatened, endangered, or of special concern **(Fig. 60)**. Most of these rare animals are not provided any type of protection beyond generally being prohibited from taking. Taking amphibians, reptiles, and plants, except for those listed on the federal threatened or endangered list, however, is allowed in Kentucky.

The Kentucky Department of Fish and Wildlife Resources (KDFWR), through a cooperative agreement with the U.S. Fish and Wildlife Service, is the state agency designated to protect threatened and endangered animal species in Kentucky. NPC is the lead agency in the state for the protection of threatened and endangered plants. KDFWR has the regulatory authority to adopt a state list for those threatened and endangered animals not protected at the federal level. In 1972, such a list was adopted, but was later withdrawn from Department regulations due to a conflict in statutory language. This language was clarified in the 1988 legislative session, however, KDFWR has not readopted a list. Currently, there is no official state listing process for species believed to be rare in Kentucky.

Widely varying opinions exist regarding what is rare and endangered in Kentucky, according to KDFWR. A possible solution to this problem lies in the creation of a forum in which experts from universities and state and federal agencies can reach some agreement on which species are threatened or endangered in the state. In conjunction with that effort, new statutory language, to protect the habitats on which these species depend, should be considered.

Figure 60
Threatened and Endangered Plants and Animals in Kentucky (selected species)

	Status
Kentucky Lady's–slipper	Endangered
Wild Lily of the Valley	Threatened
Small Purple Fringed Orchid	Endangered
White–haired Goldenrod*	Threatened
Running Buffalo Clover*	Endangered
Fanshell Mussel	Endangered
Kentucky Creekshell Mussel	Endangered
Bottlebrush Crayfish	Special Concern
Ohio Shrimp	Endangered
Lake Sturgeon	Endangered
Spotted Sunfish	Threatened
Trout–perch	Special Concern
Swamp Darter	Endangered
Green Treefrog	Special Concern
Southern Painted Turtle	Special Concern
Sharp–shinned Hawk	Special Concern
Blue–winged Teal	Endangered
Great Egret	Endangered
Bobolink	Special Concern
Bald Eagle*	Endangered
Osprey	Endangered
Evening Bat	Threatened
Black Bear	Special Concern
New England Cottontail	Endangered
Red–cockaded Woodpecker*	Endangered

**protected under federal law*
Source: Kentucky Nature Preserves Commission, 1991

Kentucky has 330 plant and 224 animal species and subspecies considered threatened, endangered, or of special concern in the state. Many of these species are not provided any type of protection. Only 25 rare species in Kentucky are protected under federal law.

State and Federal Recovery Programs Assist Bats, Eagles, and Some Rare Plants

Recovery programs for some endangered and threatened species have been initiated in Kentucky. Plans have been developed for all three of the state's federally–listed endangered bat species (Virginia big–eared bat, Indiana bat, and the gray bat). These plans involve site protection, population monitoring, and basic research activities. The U.S. Forest Service recently developed a policy to minimize timber harvesting along clifflines to avoid disturbing bat habitat in the Daniel Boone National Forest.

The bald eagle is also assisted by recovery plans in Kentucky which include recent hacking activities conducted at Land Between the Lakes and Dale Hollow Lake. Hacking programs attempt to restore birds near extinction to more natural populations. It requires obtaining young birds, identifying suitable sites for artificial nests, and recruiting volunteers to feed and observe the birds. In 1991, seven eagles were produced from four nests in Kentucky. Some of these birds originated from hacking programs, while others appeared to be wild. Two of the nests and four of the young occurred at the Ballard Wildlife Management Area. The other two nests were located at Land Between the Lakes. Various state, federal, and private agencies have also cooperated on projects involving protection and research on threatened and endangered species including: least terns, red–cockaded woodpeckers, little–winged pearly mussels, and Cumberland bean mussels.

Research on the habitat requirements and the life history of Short's goldenrod, a federally–designated endangered plant native to Kentucky, has been coordinated by NPC to aid in its recovery. More research, management, and protection efforts are needed, however, before these and other rare plant and animal species are considered recovered.

Many Wetlands Containing Rare Species Threatened; Over Half of Native Bats in Kentucky Considered Rare

Two–thirds of the 25 federally–listed species found in Kentucky are dependent upon wetlands for some part of their life cycle. These species are becoming increasingly rare because of the loss and degradation of wetlands. NPC, in cooperation with other state agencies and private groups, recently ranked known wetlands with regard to the habitat they provide for threatened and endangered species. Thirty–seven wetlands in Kentucky were ranked high priority, 29 of which are considered in danger of destruction **(Fig. 61)**. Due to the tenuous status and important role of wetlands, state and federal agencies are mapping Kentucky's wetland resources. Digitized wetland maps will soon be available to users of the state's computerized Geographical Information System.

Nine of the 15 bat species of found in Kentucky are considered rare by NPC. The loss and degradation of caves have contributed to the decline of Kentucky's bat populations. Loss of habitat has impacted many species of plants as well. Two of the state's federally–listed plant species are found only in Kentucky. They include Short's goldenrod and the white–haired goldenrod. Stream pollution and siltation have impacted some fish and mussel populations. Thirty–seven percent of the state's 103 mussels are considered rare and 30% of its native fish are threatened, endangered, or of special concern.

Habitat Most Critical Element Needed to Protect Rare Species; Funding Shortfalls Limit Progress

The most critical element needed to protect rare, threatened, and endangered species is undisturbed habitat in which they can live and reproduce. NPC's primary function is to identify and protect the state's natural heritage. As of October 1991, NPC has purchased over the years 6,394 acres and established 24 nature preserves in 18 counties to protect remnants of Kentucky's original habitat. These habitats support many threatened and endangered species. The 61 state, federal, and private wildlife management areas managed by KDFWR also provide habitat for rare species. Approximately 26 of these areas provide habitat to 229 of the state's rare species. The Kentucky Chapter of The Nature Conservancy also works closely with various state and federal agencies to acquire important plant and wildlife habitats and natural areas in the state.

Funding shortfalls have limited the state's ability to identify and protect threatened and endangered species habitat. In 1980, the state income tax checkoff program for nongame wildlife and natural areas provided the first state funds to purchase nongame habitat. This program has raised $900,000 over the past eleven years, which was divided equally between the NPC and KDFWR for nongame research and habitat protection **(Fig. 62)**. The average individual contribution to the nongame tax checkoff program in 1989 was $5.34, according to the Federation of Tax Administrators.

In 1990, $600,000 was appropriated by the state for the first time to purchase natural areas. At that time, the legislature also established the Kentucky Heritage Conservation Board to assist state agencies acquire important habitats in need of protection. Funding to purchase these lands, however, was not provided. The 1992 legislature appropriated $100,000 to NPC for the purchase of natural areas.

Figure 61

Priority Wetlands in Kentucky Providing Rare Species Habitat

Wetland	County	Destruction Threat
Blood River Bottoms and vicinity	Calloway	M/L
Shawnee Creek System	Ballard	M
Laurel County Swamp	Laurel	M/L
Salt River (Lower) Rolling Fork	Nelson, Hardin, Bullitt	L
Transient Lakes, etc.	Warren	L
Rockcastle County Swamp	Rockcastle	M/L
Washington County Swamp	Washington	M/L
Wayne County Swamp	Wayne	M/L
Humphrey Creek System	Ballard	M
Metropolis Lake Area	McCracken	L
Deer Creek System	Webster	M/L
Cypress Creek System (Tennessee River)	Marshall	M/L
Christian County Swamp	Christian	M/L
Logan County Pond	Logan	L
Hardin County Sloughs	Hardin	L
Hardin County Pond	Hardin	L
Simpson County Swamp	Simpson	L
Johnathan Creek Bottoms, etc.	Calloway, Marshall	L
Running Slough, etc.	Fulton	H
Pond River System	Webster, McLean, Muhlenberg, Hopkins	H
Cypress Creek System (Green River)	Muhlenberg, McLean	H
Obion Creek System	Fulton, Hickman, Carlisle, Graves	H
Bayou de Chien System	Fulton, Hickman	H/M
Clarks River System	Marshall, Graves, McCracken	H/M
Tradewater River System	Hopkins, Caldwell, Webster, Crittenden, Union	H/M
Mayfield Creek System	Carlisle, Ballard	H/M
Terrapin Creek System	Graves	H/M
Muddy Creek/Little Muddy Creek	Ohio	H/M
Fish Lake/Bach Slough/Laketon Area	Carlisle	M
Richland Slough Area	Henderson	H/M
Panther Creek System	Calloway	H/M
Highland Creek System	Union, Henderson	M
Mud River/Roundabout Swamp System	Butler, Logan, Muhlenberg	M/L
Pond Creek System	Henderson	H
Green River (mainstream)	Edmonson, Barren, Hart, Warren, Metcalfe, Grayson	M
Rough River	Ohio, Grayson	M
Henderson County Wetlands	Henderson	M

L = Low, M = Moderate, H = High

Note: Generic wetland names. Priority based on threatened and endangered species habitat

Source: Kentucky Nature Preserves Commission, 1991

Two-thirds of the 25 federally–protected rare species in Kentucky depend upon wetlands for part of their life cycle. These species are becoming increasingly rare because of the loss or degradation of wetlands.

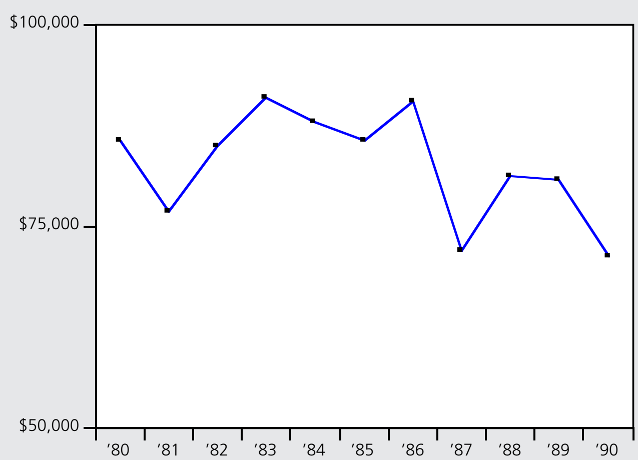
KDFWR receives approximately $40,000 annually in federal funds to protect endangered and threatened animals. These resources have been directed to determine the habitat needs for endangered bats and used for placing gates at cave entrances to protect bats and other species from human disturbance.

NPC receives approximately $10,000 annually in federal funds to protect endangered and threatened plants. This money has been used to study plants, develop recovery plans, and conduct species inventories. KDFWR and NPC also review mining permits and other development projects to determine if federally-protected threatened or endangered species will be impacted.

KDFWR also provides some funds to NPC to inventory portions of Kentucky for rare and endangered species and natural areas. Additionally, cooperative state and federal agency efforts to survey the Daniel Boone National Forest for threatened and endangered species have been initiated in recent years. Five of the seven U.S. Forest Service districts in the national forest have been surveyed. Habitats and species are being documented in the survey conducted by the U.S. Forest Service, The Nature Conservancy, NPC, KDFWR, and state universities. Several rare species have been recorded, including the Rockcastle aster which is not known to exist anywhere else in the world.

Insufficient funding and shortage of personnel continues to limit threatened and endangered species research and management in Kentucky. These aspects of endangered species management will need to be addressed, in concert with the acquisition of important habitat areas, if Kentucky is to make progress to preserve these species and maintain the state's biodiversity.◆

Figure 62
Nongame Revenue in Kentucky from State Income Tax Check Off



Source: Kentucky Department of Fish and Wildlife Resources, 1991

Since 1980, approximately $900,000 has been collected through the Kentucky Income Tax Nongame Check-off program. These funds are dedicated to nongame protection and management.

Chapter 6

Coal Mining

Coal Mining

The environmental impacts of coal mining, one of the state's leading industries, have been better controlled since the enactment of the national Surface Mining Control and Reclamation Act of 1977. For example, the occurrence of illegal and unpermitted mines, once common in Kentucky, has decreased significantly.

While progress has been made, more remains to be done to reclaim abandoned or forfeited mine sites and monitor the thousands of mine operations found in Eastern and Western Kentucky.

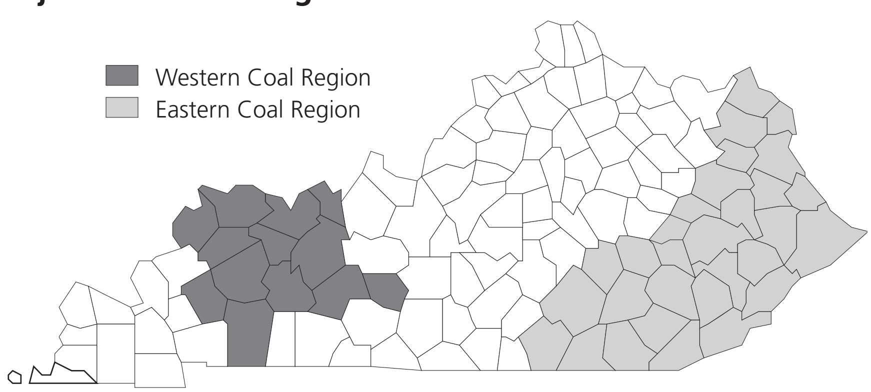
Coal Mining Facts

To understand the environmental issues associated with coal mining, it is necessary to review some facts and trends pertaining to the mining of coal in the state:

- **Coal Production at Record Levels**
  In 1990, Kentucky produced a record 179.4 million tons of coal, ranking the Commonwealth second in the nation. This was a 43% increase in state production since 1970.
- **Differences in East and West Kentucky Coal**
  Kentucky is unique in that it is the only state with coal production in two of the nation's three major coal basins. The Eastern Kentucky Coalfield lies within the Central Appalachian Basin, while the Western Coalfield is located in the Interior Basin **(Fig. 1)**. The inherent differences in the geologic formations of these two basins result in coal that is different in quality, with Eastern Kentucky coal having lower sulfur content. Eastern Kentucky now produces 75% of the state's coal. During the last 12 years, production of coal in this region has steadily increased from 97 million tons in 1978, to 131 million tons in 1990 **(Fig. 2)**. Western Kentucky coal, which is used primarily for the generation of electricity, increased from 40 million tons in 1978, to 48 million tons in 1990.

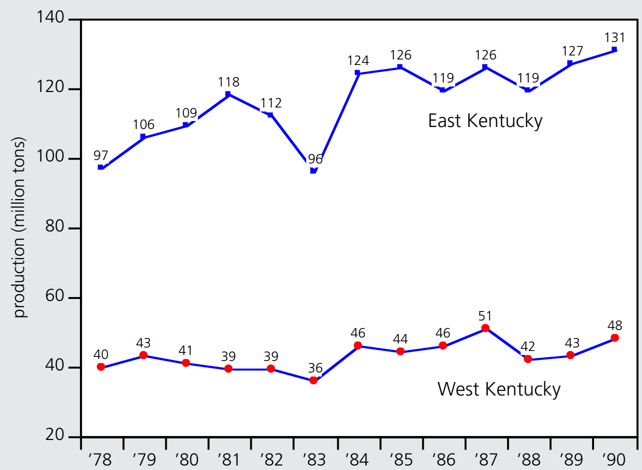
Kentucky is unique because it is the only state that has coal production in two of the nation's three major coal basins. The geologic formations result in coal that is different in quality, with Eastern Kentucky coal lower in sulfur content.

Figure 1
Major Coal Producing Counties



Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

Figure 2
Regional Coal Production in Kentucky

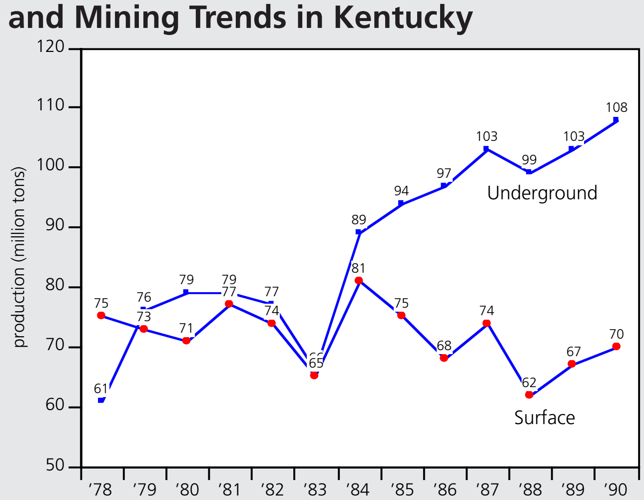


Source: Kentucky Department of Mines and Minerals Annual Reports

East Kentucky coal accounted for 75% of the state's coal production in 1990.

- **Recoverable Coal Resources Estimated at 29.9 Billion Tons**
  Bituminous coal resources in the state are estimated at 105 billion tons. Presently, 29.9 billion tons are classified as recoverable. Approximately 3.2 billion tons have been mined in Western Kentucky and 8.5 billion tons have been recovered in Eastern Kentucky.
- **Underground Mining Steadily Increasing; Accounts for 60% of Coal Produced**
  The recovery of coal by underground mining techniques has been increasing in the state since 1983 **(Fig. 3)**. During 1990, underground mining accounted for 60% of the coal mined in Kentucky.

Figure 3
Statewide Coal Production and Mining Trends in Kentucky



Source: Kentucky Department of Mines and Minerals Annual Reports

Trends show that the recovery of coal through underground mining has been increasing in Kentucky. In 1990, coal production reached state record levels.

In Eastern Kentucky, underground mining accounted for 62% of the coal mined in 1990, compared to 43% in 1978. In the western region of the state, underground mining accounted for 57% of coal production in 1990, an increase since 1978 when 43% of the coal was mined in this manner.

- **Coal Employment Decreasing**
  While production continues to increase, coal mining employment in Kentucky has declined steadily, from 50,806 jobs in 1981, to 31,486 in 1989. This decrease is due to advancements in mining technology and the increased use of highly mechanized mining equipment.
- **Ten Firms Control Nearly Half of Coal Reserves in Kentucky**
  Ten companies control nearly half of the state's estimated $1.2 billion in coal reserves. They are: Pochahontas Development Corp., Kentucky River Coal Corp., Elk Horn Coal Corp., Big Sandy Co., Kentucky Berwind Corp., Peabody Coal Co., The Pittsburg and Midway Coal Mining Co., Enterprise Coal Co., National Mines Corp., and Pegasus Resource Co. The ten companies are an even mix of landholding companies and mining firms and are mostly based outside of Kentucky.

Regulation of Coal Mining in Kentucky

While coal mining has been regulated to some degree in Kentucky since 1966, it wasn't until the Surface Mining Control and Reclamation Act of 1977 (SMCRA) that mining was addressed nationwide. Additionally, Public Law 95–87 provided for the creation of the federal Office of Surface Mining (OSM) to implement and enforce the newly–passed laws.

In 1978, the Commonwealth began implementing key provisions of SMCRA, such as the total elimination of highwalls and the control of surface effects associated with underground mining. At that time, Kentucky also began upgrading its laws, regulations, and organizational structure in an attempt to gain approval from OSM as the primary regulating authority in the state.

Kentucky obtained "primacy" in 1982 to carry out the federal surface mining program. The Kentucky Department for Surface Mining Reclamation and Enforcement (DSMRE) became the primary regulatory authority, and OSM shifted into an oversight capacity. In this role, OSM annually reviews and evaluates the state's surface mining program. These reports and data provided by DSMRE were reviewed to evaluate the environmental conditions associated with coal mining in Kentucky.

2,006 Surface and 1,449 Underground Mines Active in Kentucky

Coal mining and reclamation activities are required to be permitted by DSMRE before operations begin. The permit process is one tool used to control coal mining and to ensure proper reclamation of mine sites. The development of the permit application requires the applicant to collect geological, hydrological, and biological information pertinent to the proposed mine site. Based on this information, the applicant must design a mining and reclamation plan to minimize adverse environmental impacts and restore the affected land to a productive level. During the permit review process, DSMRE is required to evaluate the application and make a determination that mining will be conducted in a manner which complies with all regulations and that the reclamation plan is achievable.

Since 1978, thousands of permits have been issued for coal mining in Kentucky **(Fig. 4)**. These include the following:

- "Pre–law" permits which were issued to surface mines from 1966 to 1978;
- Interim permits which were issued to surface and underground operations from 1978 to 1982; and
- Permanent program permits which cover operations that were active on, or that began after 1982.

Figure 4
Coal Mining Permits in Kentucky

Year	New Permits: Surface	New Permits: Underground	New Permits: Other[1]	Permit Types: Interim	Permit Types: 2–acre Exemption	Permit Types: Permanent	Permit Types: Coal Exploration	Permit Modifications, Renewals
1978	240	117	316	—	—	—	—	—
1979	273	625	349	—	—	—	—	—
1980	211	371	536	—	—	—	—	—
1981	165	337	823	—	—	—	—	—
1982	645	461	429	—	—	—	—	—
1983*	679	91	23	—	587	—	957	53
1984**	1,579	987	256	—	899	—	1,391	385
1985	652	220	31	—	308	—	866	887
1986	347	128	47	—	157	—	483	861
1987	275	126	212	1,315	55	3,442	428	496
1988	184	97	24	654	0	3,733	584	1,312
1989	152	68	17	507	0	3,622	485	1,868
1990	114	63	16	315	0	3,733	508	1,455

** State assumed authority to issue permits.*
*** Interim operations repermitted.*
[1] *Preparation plants and associated facilities*

Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

Permitting is a tool used in Kentucky to regulate the mining of coal and to ensure proper reclamation of the mine sites. Currently, Kentucky has 3,455 surface and underground coal mine operations permitted.

In addition, various revisions, amendments, successions, and renewals are also issued by DSMRE to these permits.

As of December 1991, Kentucky had 4,174 active permits which include the following:

- 2,006 surface mines,
- 1,449 underground mines,
- 466 coal preparation plants,
- 146 two–acre mine sites, and
- 107 associated facilities.

Included in this total are 409 interim mine permits. Of these sites, 108 are in bond forfeiture, while 229 are progressing toward bond release. The remaining 79 interim permits await state action.

Two–Acre Mine Sites and Coal Exploration Abuses Better Controlled

During 1982 through 1987, coal mining operations less than two acres were exempted from the requirements of SMCRA. The program exempted those operations from performance standards, except when site conditions warranted. Kentucky required permits for two–acre sites and issued more than 2,000, until the exemption was repealed by OSM in 1987 due to mining abuses. Approximately 700 two–acre permits issued in the state resulted in bond forfeiture.

State law also requires notices to be filed for all coal exploration operations which result in the removal of coal for testing purposes. Abuses of this program led the state to reduce the extractable tonnage limits from 250 tons to 25 tons in 1990. DSMRE currently holds notices on 482 coal explorations.

75% of Disturbed Mine Land in Eastern Kentucky; Average-Size Mine Increasing

Since 1978, 1.18 million acres of land have been included in thousands of surface, underground, or other mine–related permits **(Fig. 5)**. (This acreage does not include areas added through permit revisions and amendments). In December 1991, 242,887 acres were disturbed by active mining operations. Nearly 75% of this acreage was located in Eastern Kentucky **(Fig. 6)**.

During the past 12 years, underground mines have accounted for 49% of the acreage permitted in the state (**Fig. 7)**. This high percentage is due to the requirement that the surface acreage overlying the underground works must also be permitted. Most underground mines actually disturb very little surface acreage. A review of underground mines in Kentucky, however, reveals that these sites are increasing in size as follows:

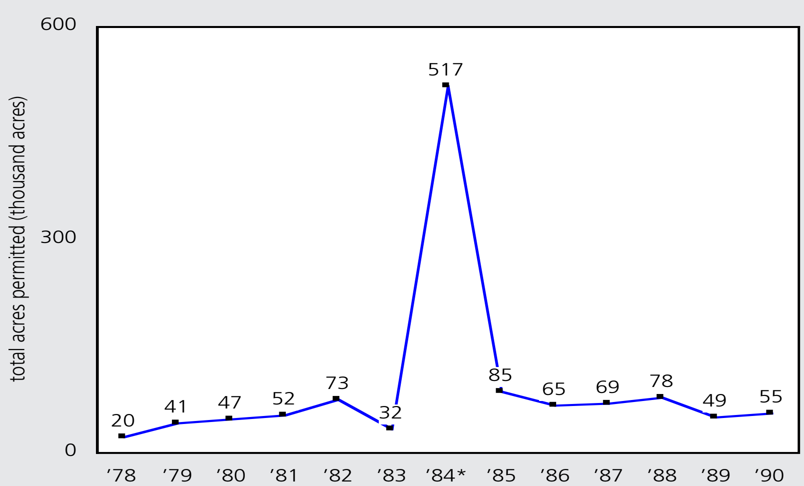
Underground Mines	**1987**	**1990**
Less than 20 acres	92%	79%
20–99 acres	3%	17%
More than 100 acres	5%	5%

Surface mines account for about 36% of the permitted acreage in the state. Surface mines are increasing in size as well as seen in the following:

Surface Mines	**1987**	**1990**
Less than 20 acres	35%	20%
20–99 acres	19%	41%
More than 100 acres	46%	39%

Figure 5

Acres Permitted for Coal Mining in Kentucky

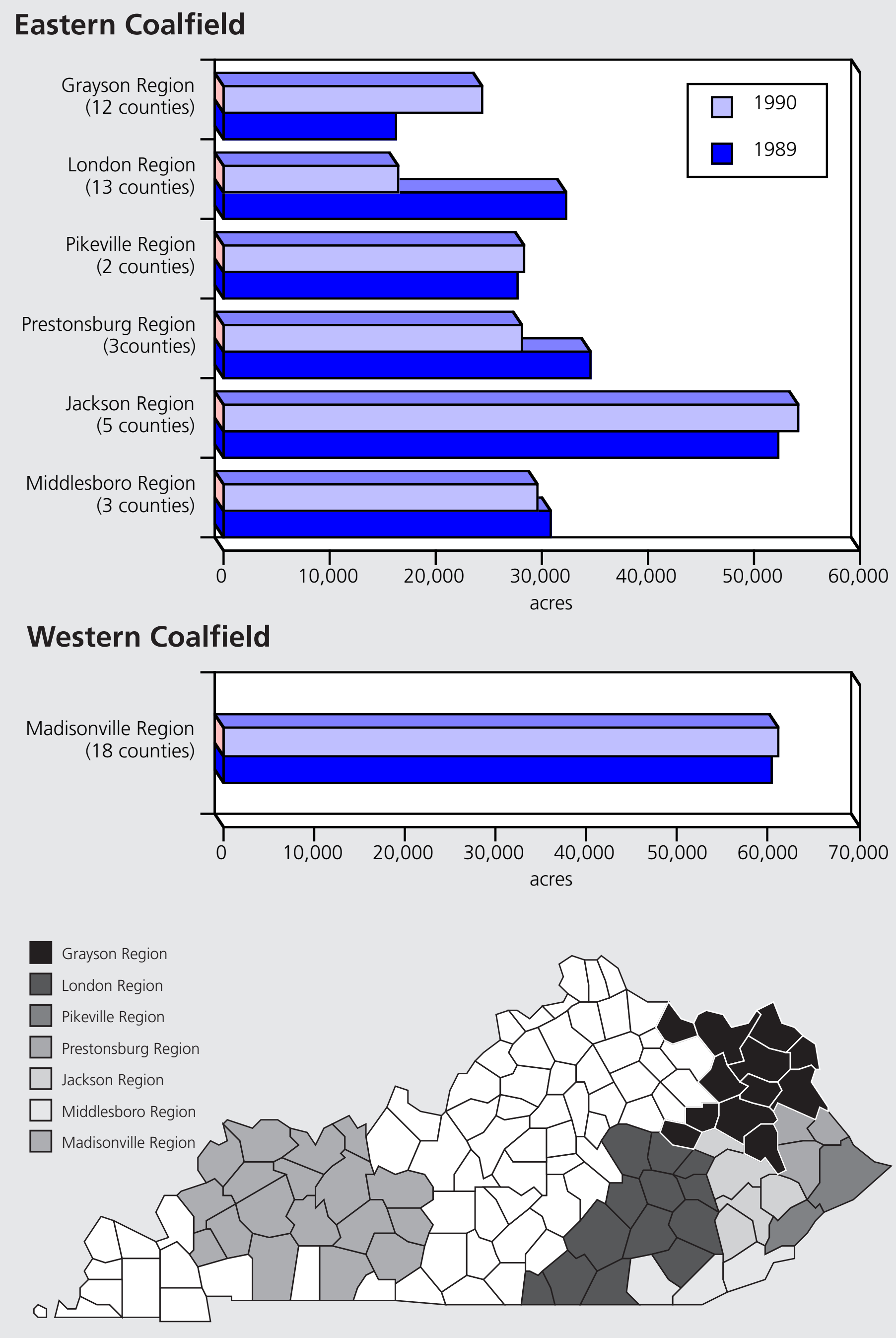


**Interim operations repermitted*

Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

Since 1978, 1.18 million acres of land have been permitted for coal mining in Kentucky. This does not include acreage added under permit revisions or amendments.

Figure 6
Acreage Disturbed by Coal Mining in Kentucky by Region

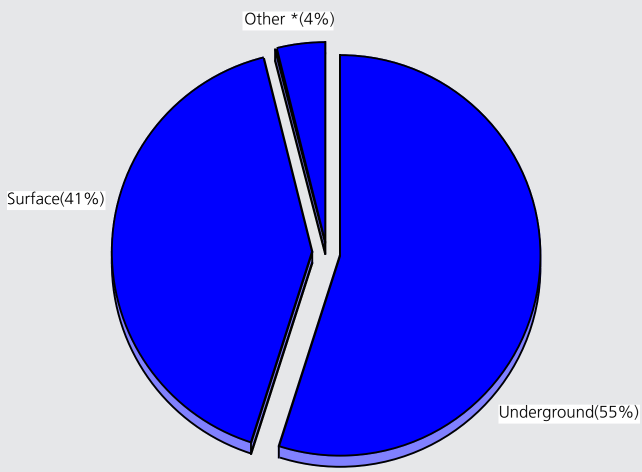


Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

Kentucky has 242,887 acres of land currently disturbed by coal mining. Almost 75% of this disturbed acreage occurs in Eastern Kentucky.

Figure 7

Percent Acreage Permitted by Mine Type in Kentucky



**Other includes combination, prep plants, haul roads, load out facilities and refuse disposal areas.*

Note: Based on 1.2 million acres permitted since 1978.

Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

Underground mines account for 55% of the acres permitted for mining in Kentucky. Most underground mines disturb very little surface acreage. About 79% of the 1,449 permitted mines disturb less than 20 acres.

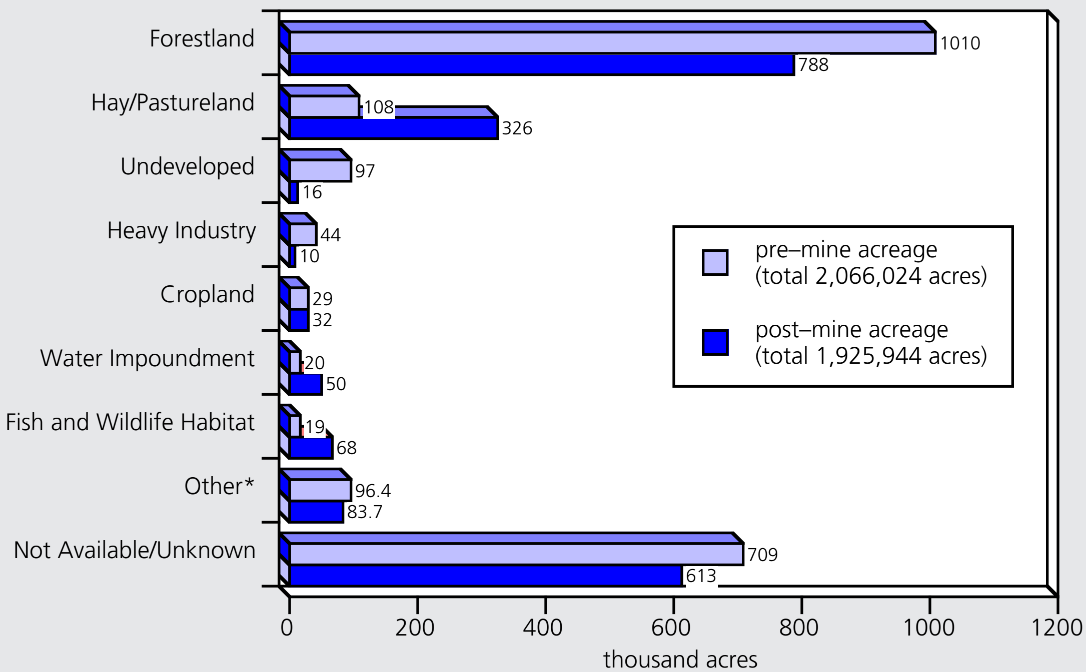
Forestland, Hay/ Pastureland Most Affected by Coal Mining

Mining activity is considered a temporary use of the land which must be restored to its original condition, unless a post–mining land use change is granted by the state. Since 1978, nearly half of the acreage permitted was originally forest. About 40% of that land was restored to forestland **(Fig. 8)**.

During this same period, 108,000 acres of hay/pastureland were permitted for mining. Three times this acreage (326,000 acres) has been reclaimed to hay/pastureland, indicating a preference by mine operators for this post–mine land use. The Kentucky Department of Fish and Wildlife Resources (KDFWR) has expressed concern that most of the hay/pastureland is reclaimed with Kentucky 31 fescue. While fescue provides a stable ground cover, this grass has had a detrimental impact on wildlife populations and the Department has discouraged its use. A requirement to use a mixture of different grasses when reclaiming sites has been recently provided for in state revegetation regulations. State regulations to more fully assess and minimize mining impacts to fish and wildlife resources, as required by federal law, have been under development since 1985. The regulations were filed in March 1992 and essentially adopt the federal language which requires case-by-case review of fish and wildlife impacts of coal mining activities.

KDFWR has also encouraged the creation of the fish and wildlife habitat as a reclamation option. Data indicates that operators are increasingly using fish and wildlife habitat as a post–mine reclamation option. Mines have affected 19,000 acres of fish and wildlife habitat, but an estimated 68,000 acres have been reclaimed to this use. This same trend can generally be seen in the use of water impoundments for reclamation of mine sites.

Figure 8
Pre–mining/Post–mining Land Use Comparisons in Kentucky (1978–1990)



**Includes grazing, commercial, light industry, recreation, and public services*

Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

Land must be restored to its original use under the state's coal mining program. Trends show forestland, hay/ pastureland, and fish and wildlife habitat lead in post–mine land uses.

Enforcement

Compliance at Mine Sites Continues to Improve; 61.5% of Mine Operations Meet Permit Conditions

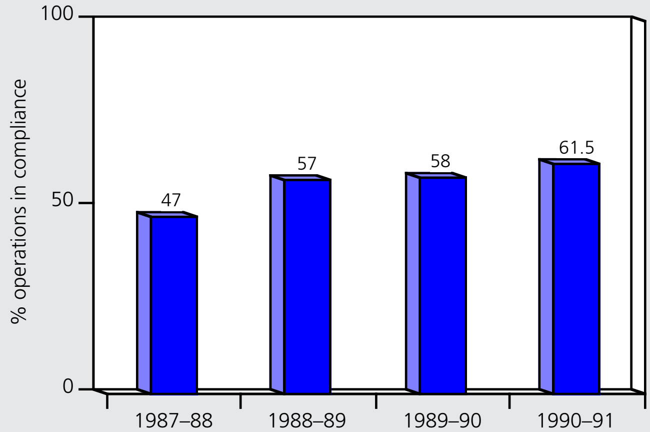
Increased enforcement of the state's surface mining rules and regulations has led to improvements at mine sites. In July 1991, OSM found that 61.5% of Kentucky's mine operations were in full compliance with all permit conditions and performance standards. This represents steady progress in industry compliance from 47% in 1987, 57% in 1988, and 58% in 1989 **(Fig. 9)**.

One reason for these improvements was the infusion of $13.5 million of federal money into Kentucky's program. These funds resulted from the 1987 settlement of a lawsuit filed by the National Wildlife Federation and the Kentucky Resources Council which alleged a systematic breakdown in the enforcement of state surface coal mining laws and regulations.

Kentucky used the money to develop and implement an aerial overflight program which routinely inspects and photographs all permanent program permit sites. Funds were also used to hire and train additional inspectors, and to add more attorneys to pursue legal actions against violators.

Additionally, DSMRE improved the Surface Mining Information System (SMIS) to provide for better tracking of inspection and enforcement activities, mine ownership and operation information, and improved permit blocking capabilities. Permit blocking prevents the issuance of permits to individuals who have unabated violations, unpaid civil penalties, or forfeited permits.

Figure 9
Compliance of Kentucky Coal Mining Operations



Note: based on fiscal years (July-June)
Source: U.S. Office of Surface Mining, Annual Reports

According to the U.S. Office of Surface Mining, 61.5% of Kentucky's mine sites were meeting their permit requirements as of July 1, 1991. This demonstrates a steady improvement in compliance since 1987.

The Applicator Violator System (AVS), established and operated by OSM in 1988, was designed to prohibit the issuance of permits to violators of surface mining laws and regulations. In 1990, OSM processed 1,495 permit applications from Kentucky through the AVS. The system identified 131 operators with outstanding mining violations which required action prior to the issuance of the permit **(Fig. 10)**. The continued refinement of the AVS should greatly assist in abating mining violations.

Figure 10
Background Checks on Kentucky Coal Mine Operators (Applicant Violator System)

	1989	1990
Permits processed through AVS	1,771	1,495
Number with potential problems	n/a	895
Number where violation required action prior to issuance of permit	n/a	131

n/a—information not available
Source: U.S. Office of Surface Mining, Annual Reports

The Applicant Violator System was established in 1988. The system, operated by the U.S. Office of Surface Mining, is designed to identify mine operators with violations and require correction prior to the issuance of any new permits.

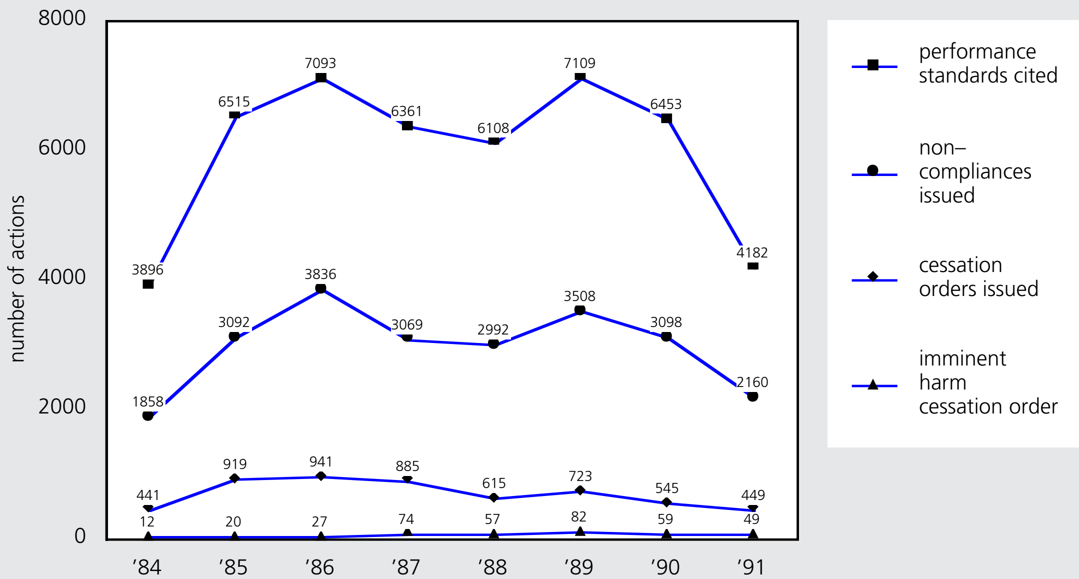
4,182 Mining Violations Cited in 1990; Penalties Increase, But Most Not Collected

DSMRE is required to perform monthly inspections for all active permits, and quarterly inspections at all inactive mines, to determine compliance with up to 45 different performance standards. In 1991, DSMRE's 160 field inspectors performed 21,866 partial and 17,176 complete inspections. Historical coal mine inspection trends are as follows:

Year	Partial Inspections	Complete Inspections
1984	32,761	34,895
1985	32,545	31,307
1986	34,065	31,786
1987	31,876	29,375
1988	28,916	25,992
1989	26,222	19,417
1990	24,890	18,044
1991	21,866	17,176

In 1991, inspections resulted in 2,160 notices of non–compliance and 4,182 violations of individual performance standards **(Fig. 11)**. The number of mining violations recorded in Kentucky has remained fairly constant between 1985 and 1990. In 1991, the number of

Figure 11
Coal Mining Enforcement Activities in Kentucky



Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1992

The citation of mining violations has remained fairly consistent in Kentucky since 1985. In 1991, violations recorded dropped to the lowest rate since 1985. Uncorrected violations can lead to the issuance of Cessation Orders which require the mine to stop operation until the problems are resolved. In 1991, 449 Cessation Orders were issued by the state.

violations cited declined 35%. This was due to a drop in permitted operations (approximately 180) in addition to many operations completing reclamation and becoming inactive with fewer standards to violate, according to DSMRE. The most frequent violations cited were:

- General permit provisions (18%)
- Sediment control (15%)
- Backfilling and grading (12%)
- Access roads (7%)
- Water quality (1%)
- Revegetation (1%)

The Department has the authority to impose additional enforcement actions, commonly known as Cessation Orders. These orders require the operator to cease coal extraction until violations are corrected. In 1991, 449 Cessation Orders were issued for failure to correct violations in a timely manner. Forty–nine orders were issued in response to imminent harm or potential danger to public health.

Cessation Orders impose a mandatory penalty assessment. Between 1986 and 1990, DSMRE collected $9 million in penalties, according to the Division of Hearings. A majority of the fines assessed by the Department were written off as uncollectible.

1,937 Permits Covering 36,704 Acres Forfeited Since 1984; About Half Reclaimed

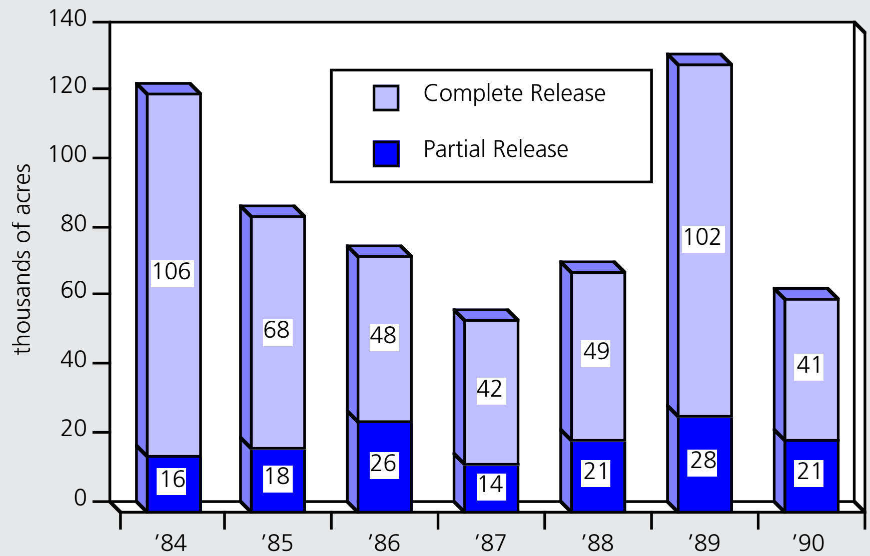
Federal and state law require every permitted operation to post a performance bond before mining begins. The bond amount is based on the site conditions and the permit plan. The bond is retained in its entirety during the mining operations. Portions of the bond can be released as various stages of reclamation are achieved. After mining ceases, reclamation must be successful for a period of no less than five years before the entire bond can be released. Currently, Kentucky retains $823 million in performance bonds. Approximately 88% are issued through surety companies with the remainder being cash, letters of credit, certificates of deposit, or financed through the State Bond Pool.

Between 1984 and 1990, DSMRE partially or fully released 14,272 bonds covering 641,000 acres of land **(Fig 12)**. During this period, 1,607 permits were forfeited covering more than 36,000 acres, representing a bond forfeiture rate of 10.1% **(Fig. 13)**. More than $25 million in bonds were collected as a result of these forfeitures. The counties with the most acreage involved in bond forfeitures are located primarily in Eastern Kentucky **(Fig. 14)**. The leading counties and acreage forfeited between 1984 and 1990 were as follows:

- Leslie (3,447 acres)
- Pike (2,486 acres)
- Knox (1,809 acres)
- Clay (1,801 acres)
- Laurel (1,493 acres)
- Butler (1,420 acres)
- Magoffin (1,244 acres)
- Whitley (1,398 acres)
- Breathitt (1,123 acres)
- Owsley (1,120 acres)

Figure 12

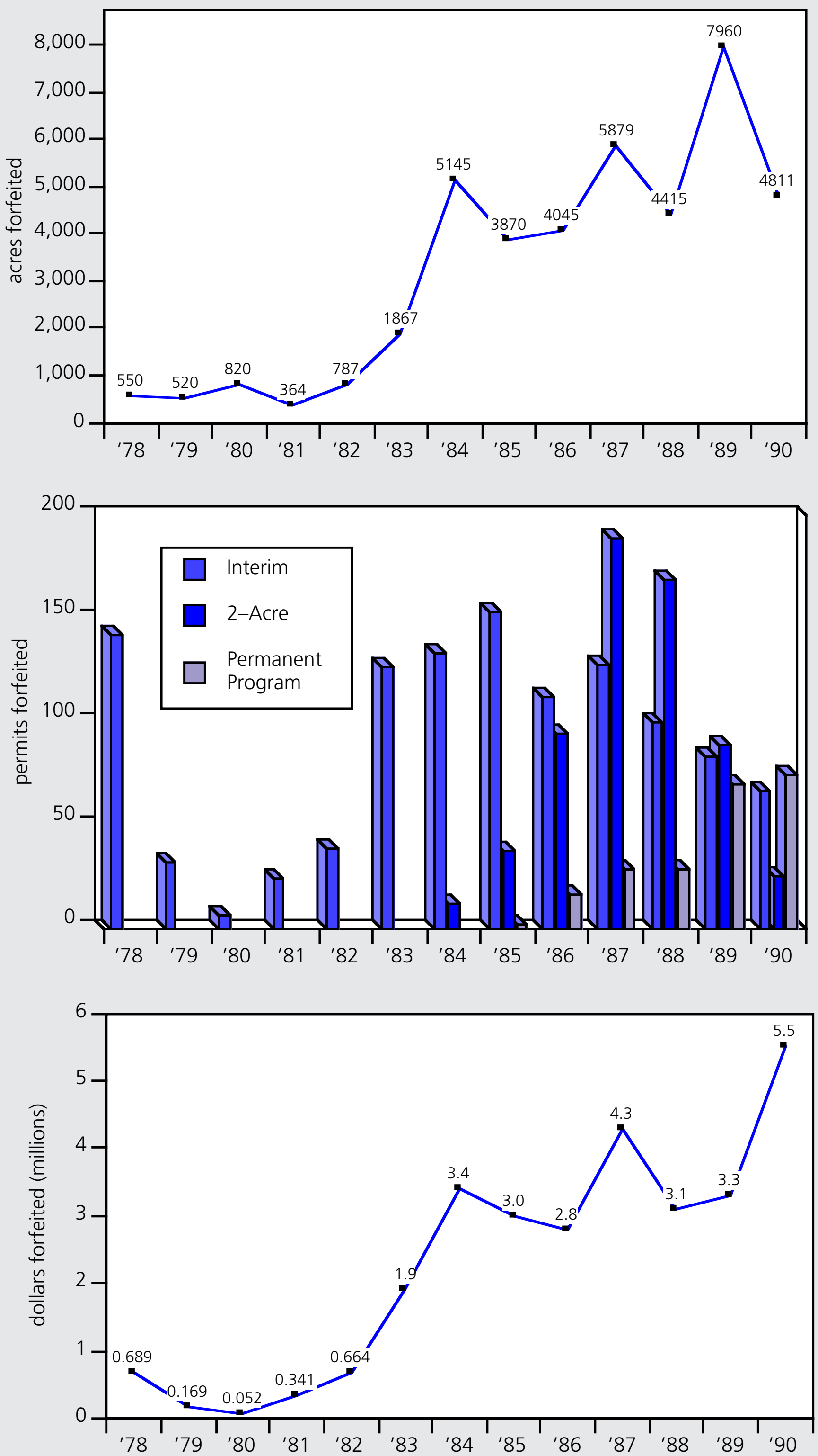
Acres Partially or Completely Released Under Kentucky Coal Mine Bonds



Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

State and federal law requires every permitted mine operation to post a reclamation bond. Kentucky currently retains $823 million in bonds. The state partially or fully released 14,272 bonds covering 641,000 acres of mine land between 1984 and 1990.

Figure 13
Mine Acreage, Permits, and Bonds Forfeited in Kentucky

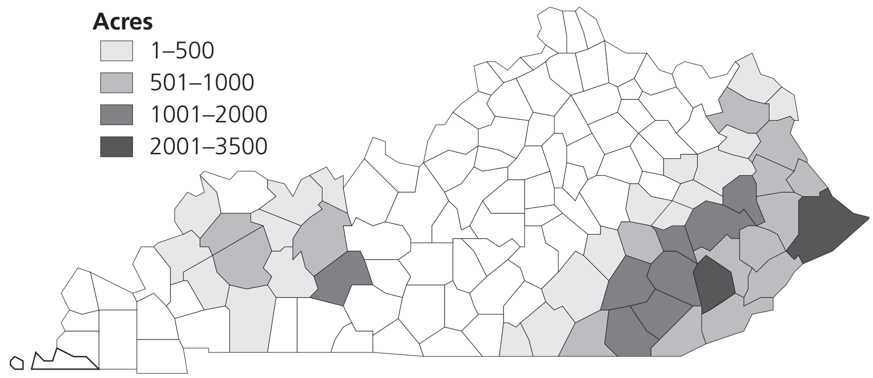


Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

One possible result of the failure to correct mining violations is revocation of a permit and bond forfeiture. Between 1984–1990, 36,125 acres were forfeited under 1,607 mine permits. The state collected $25.4 million in bonds to reclaim the sites.

Leslie and Pike counties led the state in the number of coal mine acres forfeited between 1980 and 1990.

Figure 14
Permitted Coal Mining Acres Forfeited by County (1980–1990)



Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

Between 1984 and 1990, 21,470 acres (59%) of the bonded acreage forfeited was reported reclaimed **(Fig. 15)**. The state's ability to properly reclaim these and other sites has long been a concern of OSM. A 1990 OSM survey of 42 forfeited sites in Kentucky, revealed that 74% had insufficient bonds to reclaim the site. OSM has calculated that the average bond amount needed to reclaim a site is $7,000 per acre for surface mines, and $6,400 per acre for underground mines. Bond levels in Kentucky range from $1,463 to $3,150 per acre for surface mines, and $2,233 to $2,592 for underground mines. Due to inadequate bonds, many forfeited sites, although considered stable, are not reclaimed to meet required standards, according to OSM. The agency has indicated that it takes the state an average 18 months to reclaim a forfeited mine site.

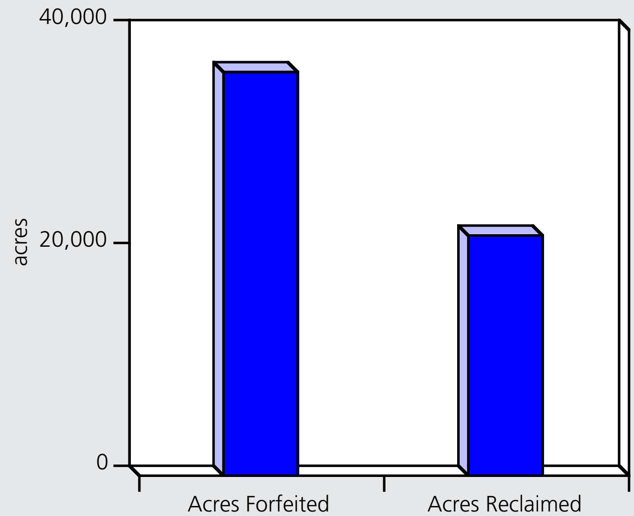
In 1986, Kentucky established a voluntary program to assist small operators obtain bonds. Currently, 32 companies are participating in the State Bond Pool and 231 bonds have been issued. Members are assessed a $500 to $2,000 bond fee per acre, depending on the operator's history. In addition, a coal severance tax is assessed on all pool participants. The State Bond Pool balance is currently $12.1 million.

Since 1986, one operator with three permits participating in the pool proceeded to bond forfeiture. One of these permits has since been forfeited at $99,100, and liability for the other two permits is $213,000. In 1990, the State Bond Pool Commission initiated an actuarial study of the bond pool program to review the solvency of the fund, bonding levels, and other issues. The final report was expected to be complete in December 1991, but has not yet been finalized.

Illegal Mining Controlled; Indictments Result in 53 Criminal Convictions Since 1985

Illegal or unpermitted mining operations, once a major problem in Kentucky, have virtually been eliminated, according to OSM **(Fig. 16)**. Illegal mining activities have been controlled through increased surveillance and a reduction in the extractable coal tonnage limits for exploration notices and personal noncommercial use from 250 tons to 25 tons. In 1985, after illegal mining was changed from a misdemeanor to a felony, DSMRE obtained its first felony conviction. Since then, 53 individuals have been convicted of illegal mining in the state.

Figure 15
Coal Mine Acreage Forfeited and Reclaimed in Kentucky (1984–1990)

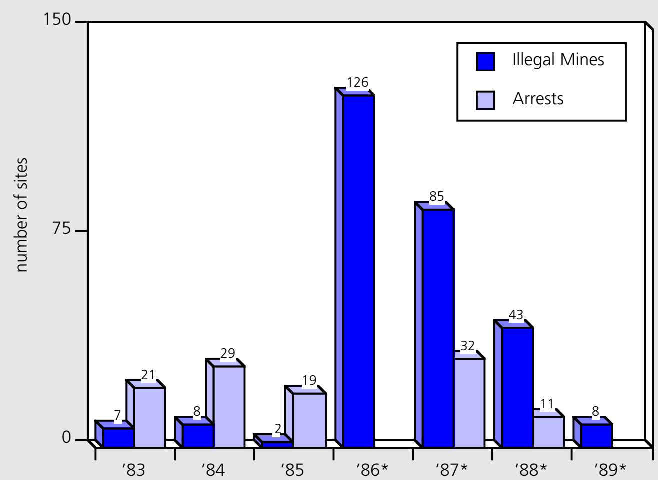


Source: Kentucky Department for Surface Mining and Reclamation and Enforcement, 1991

Records show that of the 36,125 acres forfeited under coal mine bonds in Kentucky since 1984, about 59% have been reclaimed by the state.

Illegal mining, once a major problem in Kentucky, has virtually been eliminated due to an increase in state enforcement efforts. Since 1985, 53 individuals have been convicted or pled guilty to illegal mining.

Figure 16
Illegal Mining in Kentucky



**Sites discovered through federal/state helicopter reconnaissance of one eastern Kentucky county with known problems of illegal mining activity.*

Source: U.S. Office of Surface Mining, Annual Reports

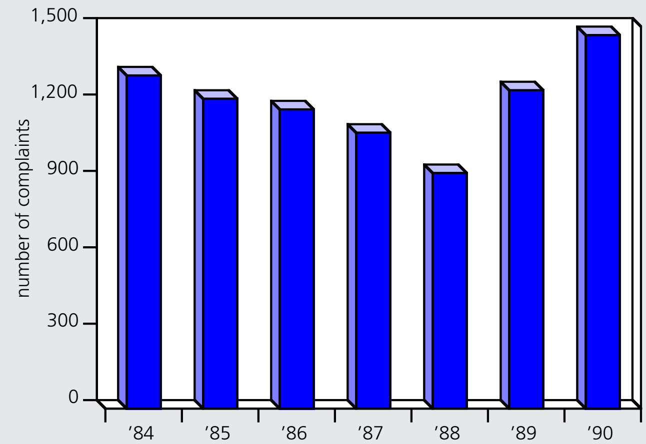
Blasting Responsible for 70% of Mining Complaints; State Leads Nation in Use of Explosives

Citizens may request that inspections be conducted at mine sites to determine if violations are occurring. In 1990, DSMRE received 1,464 citizen requests for inspections, primarily from Eastern Kentucky **(Fig. 17)**. Approximately 70% of these complaints alleged blasting damage to homes or domestic water supplies.

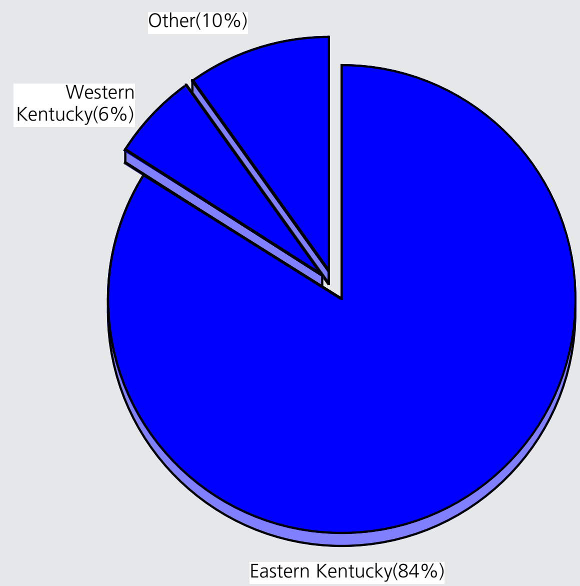
Blasting is often a major component of the mining process. Kentucky leads in the use of explosives, consuming 20% of the 4.8 billion pounds of explosives used nationwide **(Fig. 18)**. DSMRE purchased seismographs and trained inspectors in their use to better assess mine blasting problems. All blasting conducted at coal mines must be performed by a licensed and certified blaster. Currently, 730 blasters are certified by DSMRE.

Citizen complaints often allege the loss or disruption of a water supply due to underground mining. While the federal surface mining law requires the replacement of water loss from surface mining activity, it does not clearly address water loss from underground mining. Because of continuing litigation on this issue, DSMRE has taken the position that the agency does not have jurisdiction to act on the disruption of groundwater caused by underground mining operations. State legislation that would require an operator to replace diminished or contaminated water supplies caused by underground mining was proposed in the 1990 and 1992 Kentucky General Assembly, but failed to pass.

Figure 17
Complaints Regarding Mining Activities in Kentucky

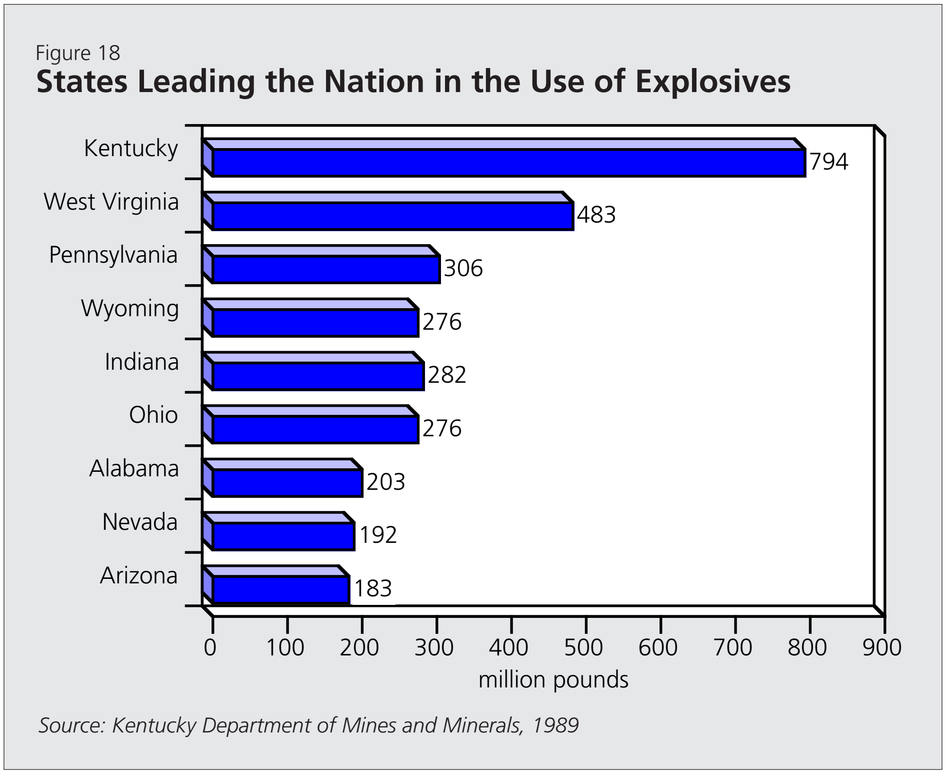


Distribution of Complaints by Region



Source: Kentucky Department for Surface Mining Reclamation and Enforcement, 1991

In 1990, the state received 1,464 citizen complaints regarding coal mining. Approximately 70% alleged underground mine blasting damage to homes or domestic water supplies.



Kentucky leads the nation in the use of explosives. The state used 20% of the 4.8 billion pounds sold nationwide for mining, road building, and other activities. Currently, 730 blasters are certified by the state to use explosives in coal mining.

Subsidence from Underground Mining a Concern; 245 Claims Filed with State Mine Subsidence Insurance Fund, 15 Result in Settlements

Since the passage of SMCRA in 1977, the repair, replacement, or compensation of landowners for the surface damage caused by underground mining, known as subsidence, has been debated. The debate centers around changes made to the federal law. In 1983, the provision which required operators to repair damaged structures caused by underground mining, or compensate owners, was deleted from the federal surface mining rules and deferred to state law. Environmental groups challenged the rule and the courts struck it down in 1990. This ruling has been appealed and its final outcome may take several years to resolve in the courts.

In the meantime, subsidence from underground mine sites will continue, especially due to the increasing use of high extraction mining techniques such as longwalling. This technique allows for greater extraction of coal through the removal of mine shaft supports, allowing the overburden to collapse as the equipment moves forward. These mine operations are required to have subsidence control plans and maintain the hydrologic balance. OSM, however, has criticized the Kentucky program because the majority of the permits and plans do not adequately address subsidence impacts on water, specifically groundwater recharge areas and streams. While some operators have agreed through their subsidence plans and permits to compensate landowners for damages, most cases involving subsidence have been handled through private lawsuits. State regulations to more fully regulate subsidence resulting from underground mining, as required by federal law, have been under development for the past few years.

Subsidence caused by mining led to the creation of the Kentucky Mine Subsidence Insurance Fund in 1986. The program provides insurance for commercial or private structures where damage has occurred after 1986. Congress, through the Abandoned Mine Land Fund, awarded Kentucky a $3 million, eight–year term grant to establish the self–sustaining insurance fund. The fund, however, does not cover land or water supply damage caused by underground mining.

Fifty–six counties were eligible to participate in the subsidence insurance program, and 46 counties initially signed up. Participation has since dropped to 34 counties. Rates are $24 to $38 for commercial policies, and $15 to $22 for single family policies. Currently, 42,000 policies are in force, providing $15,000 to $50,000 in coverage. Since the program's inception in 1986, 245 claims have been filed, 210 were closed with no payment, and 15 were settled with approximately $300,000 expended from the fund.

The Kentucky Department of Insurance has indicated that most subsidence claims were closed without payment because damage was not related to mining. While the program covers structural damage caused by both old mines and current operations, no claims have been filed against mine sites in operation after 1977.

252 Water Violations Cited in 1991; Better Assessment of Water Impacts from Mining Activities Needed

DSMRE controls water discharges from mining operations through Kentucky Pollutant Discharge Elimination System (KPDES) permits. The Division of Water (DOW) issues KPDES "general" permits to all mining operations. There are currently 4,100 KPDES permits in effect for coal operations.

The enforcement of these permits is carried out by DSMRE. The number of water violations cited at mine sites increased from 19 in 1984, to a record high of 252 in 1991. Water quality problems account for 48% of these violations, followed by effluent limits (38%), water monitoring (8%), and hydrological resources (6%) **(Fig. 19)**.

Water quality violations cited at mines were reviewed in the 1985 third quarter KPDES report prepared by DSMRE. More recent reports could not be used because of a lack of data regarding the standards that were violated. During July through September 1985, effluent exceedences of total suspended solids accounted for 57% of the mining–related water quality violations, followed by iron (20%), pH acidity (15%), and manganese standards (8%).

Data on coal mining water violations is not available in a manner to fully assess environmental impacts. Quarterly reports regarding water quality and monitoring violations are provided by DSMRE to the Division of Water through a Memorandum of Understanding. However, these reports have not been consistent in providing information on standards violated or the levels of contamination.

Figure 19
Kentucky Coal Mining Water Violations

	Water Quality	Effluent Limits*	Water Monitoring	Hydrological Resources	Total
1984	17	1	1	0	**19**
1985	13	2	2	1	**18**
1986	30	11	13	0	**54**
1987	43	20	22	1	**86**
1988	49	12	50	3	**114**
1989	41	26	43	4	**114**
1990	90	66	27	15	**198**
1991	120	97	21	14	**252**

**Effluent limits most often violated include total suspended solids, iron, pH, and manganese*

Source: Kentucky Department of Surface Mining Reclamation and Enforcement Noncompliance Reports, 1984-1991

All mines must monitor ground and surface water for contaminants. Since 1984, the state has increasingly cited water–related violations at mine sites.

The state water permits only regulate mine discharges from point sources such as sediment and treatment ponds, ditches, and impoundments. During active mining, this coverage may be sufficient since mine drainage must be diverted or controlled. Following reclamation, however, nonpoint runoff discharges can, and usually do, occur. According to the Division of Water, runoff from surface mining is potentially impacting 205 streams in nine river basins. Nonpoint runoff pollution from underground mines is threatening another 69 streams in six river basins. A majority of these degraded streams are located in the Big Sandy, Kentucky, and Upper Cumberland river basins. Runoff from surface and underground mining is also considered a potential problem at 61 wetlands and four lakes in Kentucky: Dewey, Carr, Buckhorn, and Martin's Fork.

Water permits also do not regulate mine discharges to groundwater. While coal operations are required to monitor groundwater, data has not been compiled in a manner to determine the impacts on these resources. Nonpoint pollution from coal mines is potentially degrading groundwater resources in Pike, Pulaski, Johnson, Martin, Hart, Barren, Edmonson, Lee, Breathitt, and Perry counties. Improved water quality data collection and analyses are needed to more fully assess and address mining impacts on rivers, streams, and groundwater resources in the state.

Current Impacts of Acid Mine Drainage Generally Unknown

The impacts of acid mine drainage on the state's streams and rivers has not been comprehensively assessed since 1981. Acid mine drainage is water polluted with high acidity, sulfates, and metals, and is associated with both surface and underground mining. The problem is usually more acute in underground mines. In 1981, more than 1,000 miles of rivers and streams in Kentucky were impacted by acid mine drainage.

While most acid drainage is associated with abandoned mine lands, 15% of the water quality violations at active mine sites recorded during July through September 1985, were due to exceedence of acidity standards. To address these violations, operators are required to treat acidic water by adding alkaline material to treatment ponds and backfill. During 1991, 244 miles of streams were impacted by acid mine drainage in the Big Sandy, Kentucky, Upper Cumberland, Green, and Tradewater river basins, according to Division of Water monitoring reports.

The use of artificial wetlands is a promising technique for treating acid water. The U.S. Forest Service constructed a wetland in McCreary County in 1989 to treat acid mine drainage from an abandoned coal mine that was impacting Rock Creek in the Daniel Boone National Forest. Preliminary results showed a 90% reduction in total dissolved solids, a 98% drop in sulfates, and a 100% decrease in total iron in the treated water. Also, pH increased from an acidic low of 1.9 to an acceptable 7.8 level.

Abandoned Mine Lands

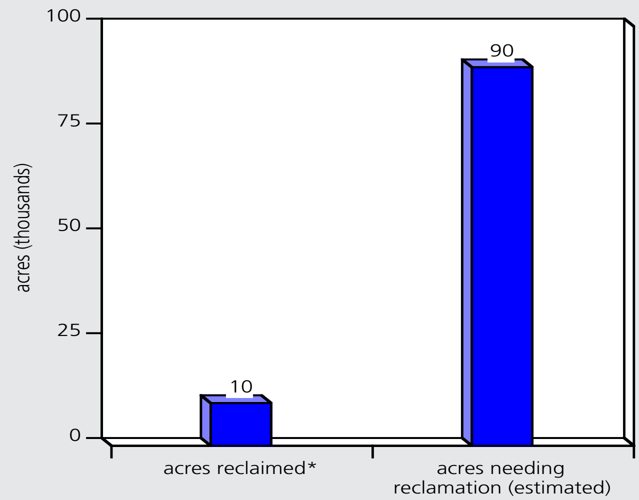
Ten Percent of Abandoned Mine Land Reclaimed; 90,000 Acres Remain

More than 10,000 acres, or approximately 10% of the 100,000 abandoned mine land acres in Kentucky, have been reclaimed through the combined efforts of the Kentucky Division of Abandoned Mine Lands and the U.S. Soil Conservation Service Rural Abandoned Mine Land Program (RAMP) **(Fig. 20)**. RAMP reclamation projects account for approximately 1,500 of the reclaimed acres.

Funds used to reclaim the 10,000 acres of abandoned sites mined prior to 1977, were provided through a federal surcharge on coal production. The federal Abandoned Mine Land Fund was given renewed life when Congress extended fee collection until 1995. Since 1977, $2.5 billion has been collected under this national program and reallocated back to the states to reclaim abandoned sites. Kentucky has paid $298 million into the fund since 1982 and has received $196 million, a return of 65% **(Fig. 21)**. An additional $38 million in funds was spent by OSM to address emergency projects in Kentucky such as landslides, fires, and subsidence. OSM is encouraging states to take over the emergency program. However, most have been reluctant to assume authority for this program due to a lack of resources and staff.

Since 1982, Kentucky has reclaimed about 10% of the 100,000 acres of abandoned mine land in the state.

Figure 20
Reclamation of Abandoned Mine Lands in Kentucky (1982–1990)



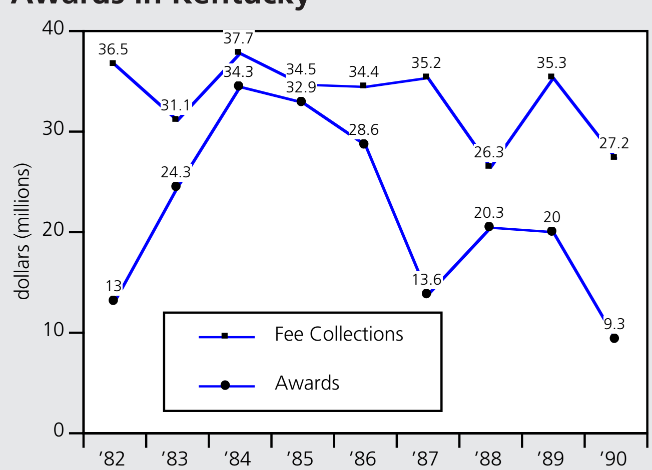
**Projects not reflected in above acreage:*

- *14 waterlines completed*
- *4 waterlines under construction*
- *3 stream restorations*
- *1 acid mine drainage project*
- *1 stabilization project*
- *38 maintenance projects*
- *1 mine fire–related subsidence and fencing*
- *Hundreds of mine portal closures*

Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1991

Since 1982, Kentucky has paid $298 million into the federal Abandoned Mine Land Fund. About 65% has been allocated back to the state to reclaim old pre–1977 mine sites. Another $38 million was used by the federal Office of Surface Mining for mine emergency projects in the state.

Figure 21
Abandoned Mine Land Fee Collection and Awards in Kentucky



Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1991

Kentucky still has an estimated 90,000 acres of pre–1977 abandoned mine land left to reclaim. The costs to reclaim these sites are great. In addition, the state has thousands of acres of mine land that has been abandoned, or left unreclaimed since 1977. Limited resources are available to properly reclaim these sites because of inadequate bonds and, in some cases, surety insolvencies.

In 1987, Kentucky filed a lawsuit against five insolvent surety companies seeking $8 million. This claim represented the value of nearly 300 surface mining performance bonds insured by these companies. In 1989, the Kentucky Supreme Court rendered its opinion in favor of the state's claim. To date, $2.2 million has been collected under this claim.

State Regulations to Promote Remining Old Mine Sites Stall

Another option to reclaim old abandoned mine sites is remining. Remining involves the reclamation of abandoned mine sites through the recovery of coal. It is not known how much coal is available through remining, although the coal industry has expressed an interest in mining coal from these areas.

The single most significant issue affecting remining is the permittee's liability for pre–existing pollution discharges. The coal industry has been reluctant to remine abandoned mine sites due to the condition of these areas and the ability to meet regulatory requirements for water quality. Their argument has been that if a site has "bad water," such as acid mine drainage, it may be difficult to meet water quality standards even after the site is reclaimed.

In 1986, the Kentucky Legislature directed DSMRE to promulgate regulations to promote remining of previously–affected areas, including coal refuse piles and slurry ponds. Since then, the state has attempted to enact remining regulations on three occasions, all of which have been unsuccessful.

Changes in federal law and regulatory standards may be needed to encourage remining, according to OSM. The environmental community, however, believes that direct or indirect financial incentives are more appropriate to promote remining. Several attempts to change laws at the federal level to promote remining have been made. One remining measure was adopted as an amendment to the Clean Water Act in 1989. The amendment provides remining operations with some flexibility in achieving water quality standards for certain parameters. The Division of Water adopted this amendment into its water regulations in 1990. Currently, an application is under review by the Division of Water to permit the remining of a 200–acre abandoned mine site in Western Kentucky.

Lands Unsuitable for Mining

Public involvement in the permitting process is provided through SMRCA. Public notices are required for any new mining permit, as well as major revisions or amendments to any permit. Notices are also required for bond releases and changes in company ownership. Citizens are provided an opportunity to comment on these actions and may also request to visit the site with the state inspector.

Less than 2% of the mining permits applied for in Kentucky have been denied, according to state officials. Denials are usually due to unresolved technical issues or the deferral of bonds when operations fail to begin within a three–year period. Mining permits may also be rejected if they occur in an area designated as unsuitable for mining.

Two Out of 15 Lands Unsuitable for Mining Petitions Approved; Most Denied Due to Technical Deficiencies

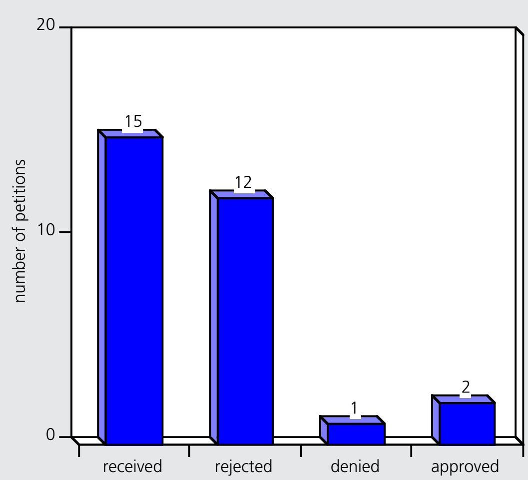
Local citizens may petition for a specific area to be designated as unsuitable for surface coal mining. Lands can be designated unsuitable if:

- ◆ Reclamation is not technologically or economically feasible;
- ◆ Mining is incompatible with existing land use;
- ◆ It causes a loss of water, food, or fiber;
- ◆ It will impact fragile or historic lands; or if
- ◆ Mining affects lands so as to endanger life or property.

Since 1983, 15 petitions have been filed in Kentucky. Two have resulted in the areas being designated unsuitable for mining **(Fig. 22)**. The Kentucky Natural Resources and Environmental Protection Cabinet (NREPC) approved the first petition in 1987 by designating a 2,900–acre area in the Cannon Creek Reservoir watershed near Pineville in Bell County as unsuitable for mining. The petition was approved based on the determination that surface disturbance resulting from coal mining would be incompatible with public use of the reservoir for drinking water and recreation. This designation was challenged by the mining applicant, but was upheld in Franklin Circuit Court in 1990.

In 1991, NREPC designated 10,500 acres of the University of Kentucky's Robinson Forest, located in Breathitt and Knott counties, as unsuitable for mining. The petition was requested to protect research being performed in the forest. NREPC ruled, however, that mining 81 acres located at the edge of the forest would not seriously affect the ongoing research the University wanted protected. The University is proceeding with the mining of these tracts.

Figure 22
Lands Unsuitable for Mining Petitions Filed in Kentucky



Source: Kentucky Department of Surface Mining Reclamation and Enforcement, 1991

The public may petition the state to request an area be designated as unsuitable for coal mining. Two petitions have been approved in Kentucky, protecting 2,900 acres in the Cannon Creek Reservoir near Pineville and 10,500 acres at the University of Kentucky's research forest located in Breathitt and Knott counties.

NREPC also ruled on a 1983 petition involving 49,000 acres in Butler and Ohio counties. The petition sought protection of the area's archaeological resources. The Cabinet's decision did not declare the area unsuitable for mining, but did require archaeological studies and measures to protect historic resources. Since then, several sites have been mined in this area under these specifications.

Most lands unsuitable petitions filed in Kentucky have been denied because they were incomplete or technically insufficient. Some states provide technical support to assist petitioners better articulate concerns and identify relevant data, enabling petitions to be judged on merit, rather than being dismissed due to technical deficiencies. Providing technical assistance to the public may help in making this process a more viable part of the state's surface mining program.◆

Chapter 7

Energy

Energy

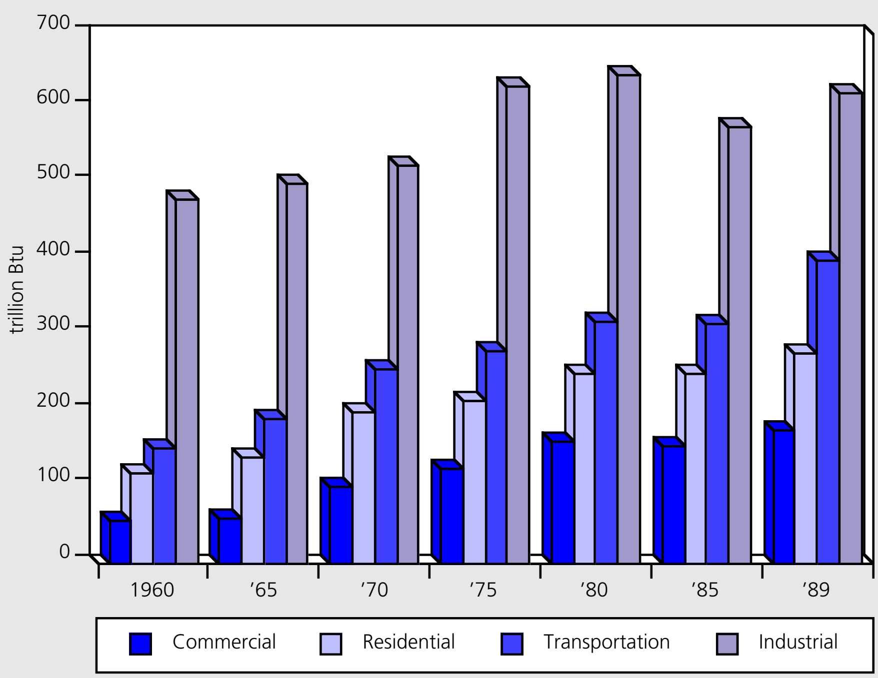
Kentucky has vast energy reserves, including coal, oil, natural gas, and wood. These resources contribute substantially to the state's economic base. The production of coal alone generated $540 million in state tax revenues during 1990.

The demand for energy resources, however, also impacts the environment. The mining of coal has affected water quality in both the Eastern and Western Kentucky coalfields. Salty brines produced during oil drilling have caused significant damage to many small streams, particularly in the Kentucky River Basin. The burning of fossil fuels emits sulfur dioxide, carbon dioxide, and other pollutants which have been linked to acid rain and global warming. And emissions from automobile exhaust have degraded air quality in metropolitan and other areas of the state. It is, therefore, important to review energy consumption and production trends to better understand environmental conditions in the state. This chapter also reviews energy costs, conservation, and current state and national energy strategies.

Energy Consumption

Residential, commercial, and industrial energy consumption has steadily increased in Kentucky during the last three decades. Total state energy use rose 81% between 1960 and 1989 **(Fig. 1)**. Kentucky is presently ranked nineteenth in the nation for energy consumption by the U.S. Department of Energy **(Fig. 2)**.

Figure 1
Total Kentucky Energy Consumption by Use

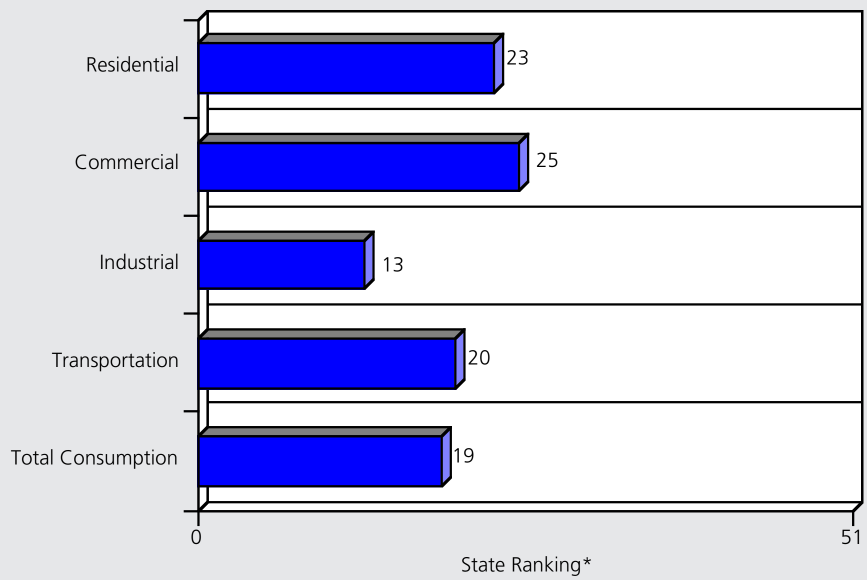


Note: 1989 data most recent available.

Source: U.S. Department of Energy, EIA State Energy Data Report, 1991

Kentucky is using more energy than ever before. Over the last three decades, energy use by businesses, households, and industries increased 81%.

Figure 2
Kentucky's National Ranking for Energy Consumption



** Includes District of Columbia*
Source: U.S. Department of Energy, EIA State Energy Data Report, 1991

The state is ranked nineteenth in the nation for total energy consumption. Energy–intensive industries such as aluminum smelters and chemical manufacturers account for Kentucky's rank as thirteenth in the nation for industrial energy consumption.

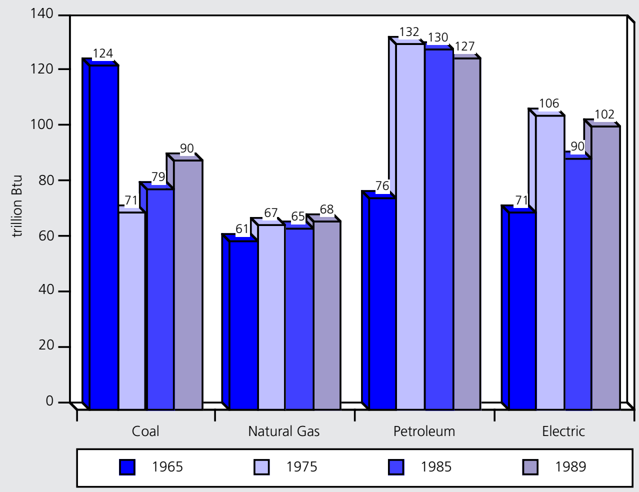
Majority of Energy Used by Industries; Petroleum and Electric Most Consumed Energy Source

The majority of energy consumed in Kentucky is used by the industrial sector. In 1989, industries used 387 trillion Btu of energy. One-third of the energy consumed was petroleum, followed by electricity (26%), coal (23%), and natural gas (18%).

Energy consumption shifts by Kentucky industries are evident since 1965 **(Fig. 3)**. For example, industrial use of coal for energy production decreased 42% between 1965 and 1975, but rebounded 27% since then. Industrial use of electricity increased 43% since 1965. About 94% of the electricity presently consumed in Kentucky is provided by 58 coal-burning units located at 21 power stations operated by nine companies **(Fig. 4)**.

Industrial use of petroleum in Kentucky increased nearly 70% during the last 24 years, from 76 trillion Btu in 1965, to 127 trillion Btu in 1989. The industrial use of natural gas has remained fairly constant in the state during the same period at about 65 trillion Btu.

Figure 3
Kentucky Industrial Energy Sources

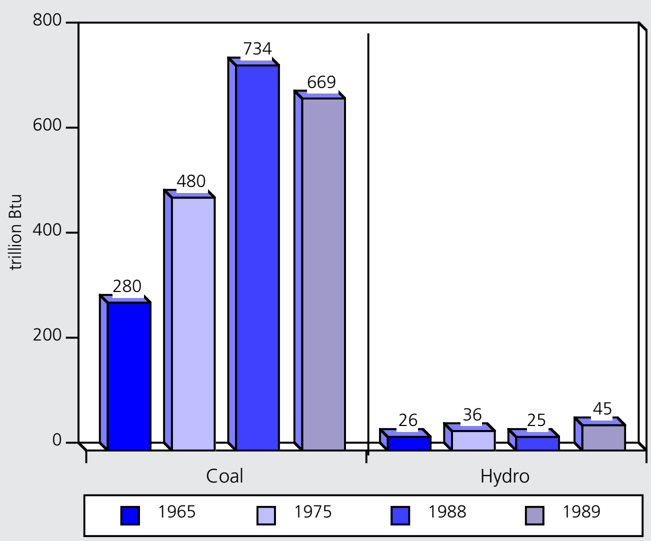


Note: 1989 data most recent available.
Source: U.S. Department of Energy, EIA State Energy Data Report, 1991

Industries are the greatest consumers of energy in Kentucky. In 1989, industries used 387 trillion Btu of energy. This included petroleum (33%), electric (26%), coal (23%), and natural gas (18%).

About 94% of the electricity consumed in Kentucky is provided by 58 coal-burning power plant units. Seven hydropower plants located on six waterways produced 45 trillion Btu of energy in 1989.

Figure 4
Kentucky Electric Energy Consumption



Note: 1989 data most recent available.
Source: U.S. Department of Energy, EIA State Energy Data Report, 1991

Residential Energy Use Increases 92% Since 1962; 83% of Homes Use Natural Gas or Electricity

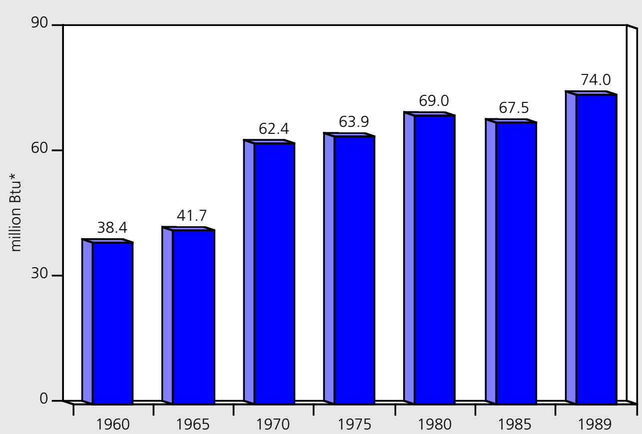
Individual households are using more energy per person for residential demands than ever before, increasing 92% since 1960 **(Fig. 5)**. The greatest residential increases occurred during the 1960s and 1970s. Personal residential energy use increased by only 7% between 1980 and 1989.

Natural gas represents the greatest household energy source used in the state. In 1989, Kentucky homes consumed 67 million Btu of natural gas, 44% of the total residential energy used. In 1975, residential use of natural gas peaked at 80 trillion Btu, but decreased to 67 trillion Btu in 1989. This may be a result of weather conditions which have been generally warmer in recent years. Also, there was a five to six-year period in the 1970s when natural gas was not available for new hookups.

During 1965, 100.4 trillion Btu of energy were consumed for residential use, compared to 146.8 trillion Btu in 1989. Most of the increase was due to the greater use of electricity **(Fig. 6)**. Residential use of electricity increased measurably since 1965. These trends can be attributed to increased population, greater availability of electricity, and new electrical technologies and conveniences. During 1989, 1.6 million homes, businesses, and industries were served by electricity, an increase of 500,000 since 1970 **(Fig. 7)**. Electricity supplied 39% of residential energy demands in 1989.

Fuel oil accounted for 14% of the total residential energy consumed statewide during 1989. Residential use of fuel oil primarily occurs in rural areas where other energy sources are not available. Direct home use of coal for heating and cooking has remained fairly constant over the past two decades, accounting for about 2% of the total residential energy used in 1989.

Figure 5
Kentucky's Residential Energy Consumption per Capita



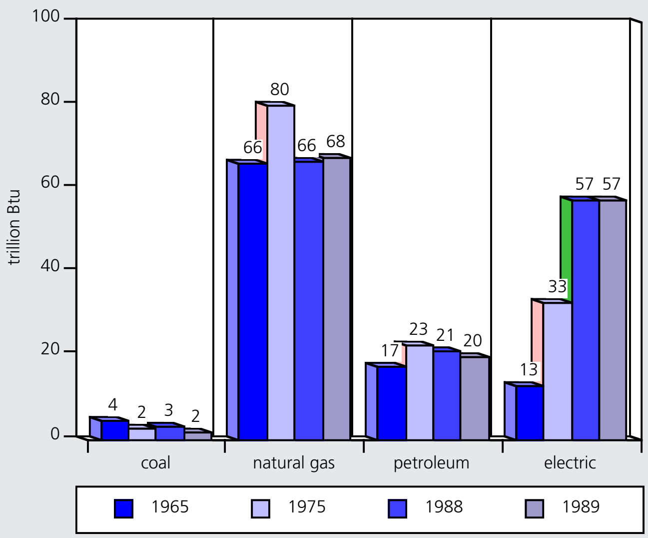
**Includes coal, natural gas, petroleum, electricity—excludes solar, wood and other biomass.*

Note: 1989 data most recent available.

Source: U.S. Department of Energy, EIA State Energy Data Report, 1991; University of Louisville State Data Center, 1991

Kentuckians are using more energy per person for residential needs than ever before. Trends show a 92% increase in total energy use per person since 1960. The largest increases occurred during the 1960s and 1970s. Energy use per person increased only 7% between 1980 and 1989.

Figure 6
Kentucky Residential Energy Sources



Note: 1989 data most recent available.
Source: U.S. Department of Energy, EIA State Energy Data Report, 1991

Natural gas is the most consumed residential energy resource in the state, accounting for approximately 47% of all energy used in homes.

The use of electricity has increased measurably in Kentucky. Between 1970 and 1989, the number of homes and businesses served by electricity increased by more than 500,000 to 1.68 million.

Figure 7
Kentucky Homes and Businesses Served by Electric Utilities

Year	Private Electric	Rural Electric Cooperatives	Kentucky Municipals	Total Customers* Per Year
1970	687,583	315,801	133,871	1,137,255
1975	787,227	385,568	152,654	1,325,449
1980	861,318	442,171	163,625	1,467,114
1985	906,180	470,000	177,267	1,553,447
1989	972,824	525,000	182,363	1,680,187

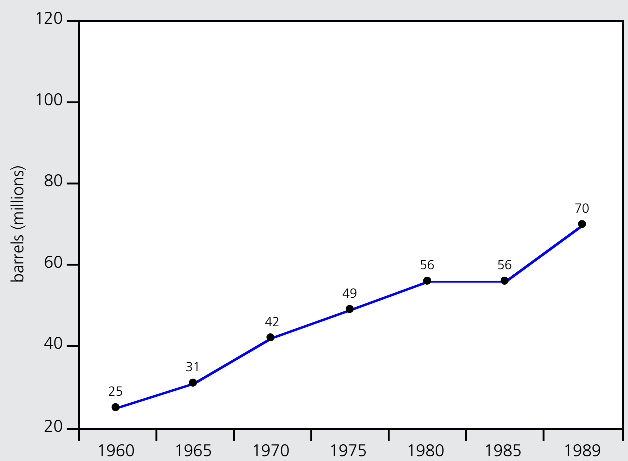
**"Customers" represents the number of billable accounts. A single occupancy home, a large family, and a large industry each count as one customer.*
Source: Kentucky Public Service Commission, Kentucky Association of Electric Cooperatives, American Public Power Association, 1991

Use of Petroleum for Transportation Increases 180%; Personal Gasoline Consumption Remains Constant

The transportation sector in Kentucky has steadily increased its use of gasoline, road oil, jet fuel, kerosene, and other petroleum fuels. State energy consumption for transportation increased from 25 million barrels in 1960, to 70 million barrels in 1989 **(Fig. 8)**. Total use of gasoline in the state during 1989 was more than double that of 1960.

While the average Kentuckian traveled 9,127 car miles in 1989 compared to 6,201 miles in 1970, personal consumption of gas has remained fairly constant **(Fig. 9)**. This can be explained by the greater fuel efficiency of automobiles which has off-set the increase in miles traveled.

Figure 8
Kentucky Consumption of Petroleum Fuels* for Transportation



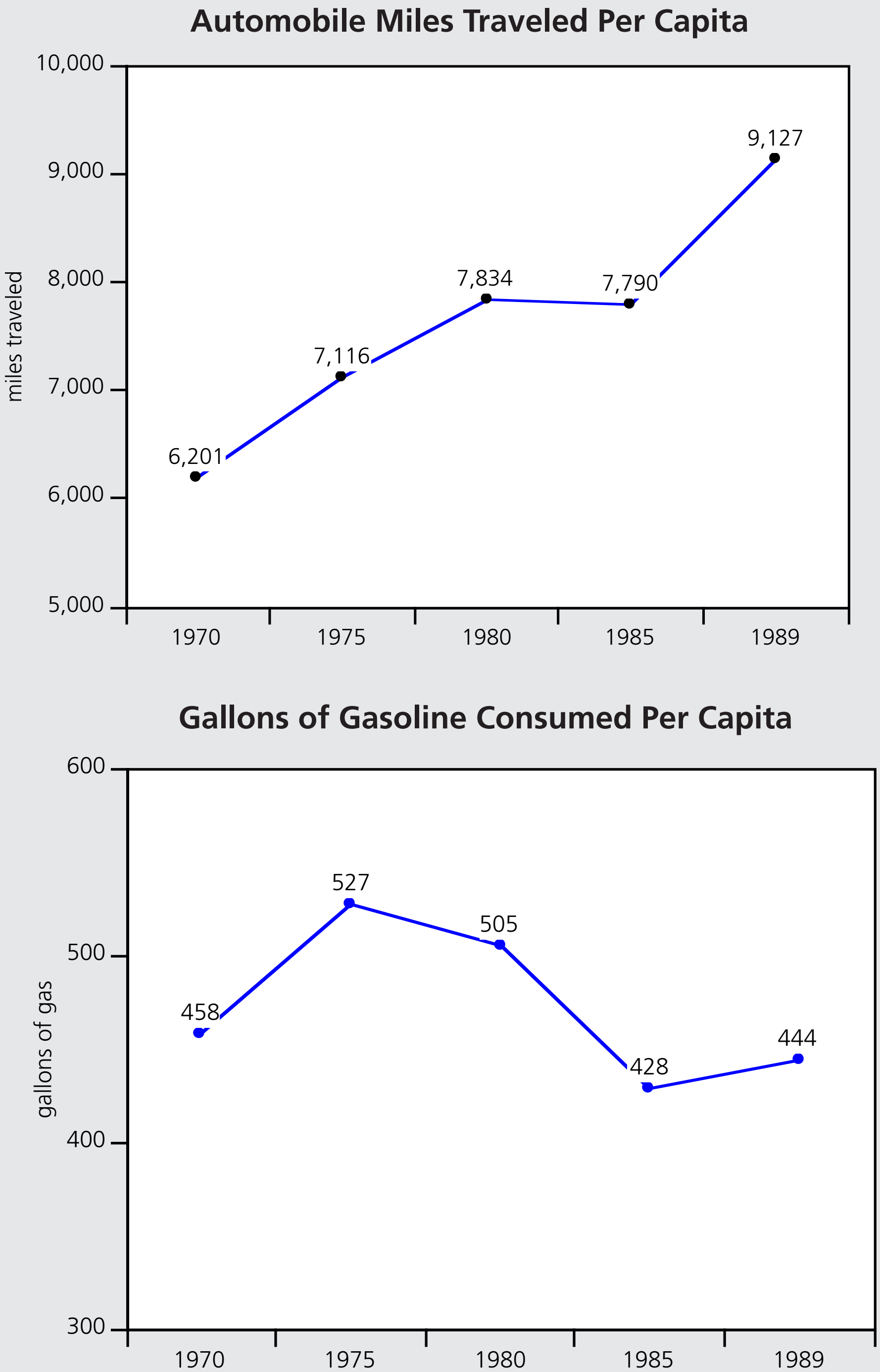
** Includes: motor gasoline, road oil, jet fuel, distillate fuel, aviation gasoline, kerosene, LPG, lubricants, residual fuel, and miscellaneous fuels.*

Note: 1989 data most recent available.

Source: U.S. Department of Energy, EIA State Energy Data Report, 1991

Total state consumption of petroleum fuels for transportation almost tripled between 1960 and 1989. This trend reflects an increasing population and greater mobility.

Figure 9
Personal Travel and Gasoline Use in Kentucky



Note: 1989 data most recent available.
Source: U.S. Department of Energy, EIA State Energy Data Report, 1991; Kentucky Department of Transportation, 1991

Kentuckians travel more automobile miles than ever before. The per capita use of gas, however, remained fairly constant over the past three decades, reflecting greater fuel efficiency in automobiles.

Energy Production and Supplies

The United States, the greatest energy consumer in the world, possesses large fossil fuel reserves to meet these demands. During 1990, domestic production supplied 83% of the nation's energy needs. This was a slight decrease from 1986 when domestic energy reserves provided 86% of U.S. demand. Nonrenewable energy reserves in Kentucky, such as coal, petroleum, and natural gas, contribute significantly to meeting these energy needs.

Nonrenewable Fossil Fuels

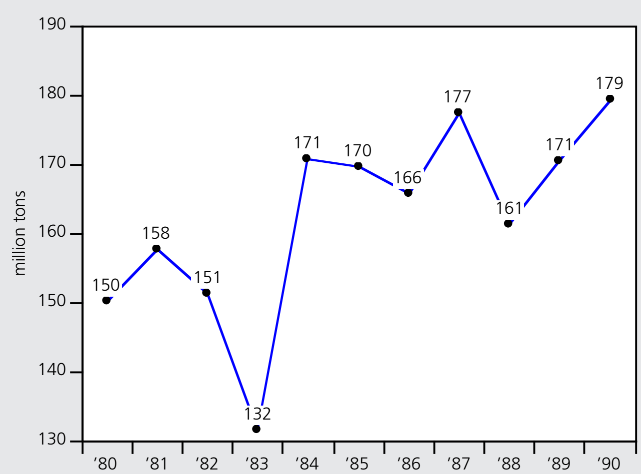
Kentucky Coal Production at Record High in 1990; Supplies 20% of Nation's Needs

U.S. coal reserves are estimated at 180 billion tons, almost one-quarter of the world's total supply. More than half of the U.S. coal reserves are located in Kentucky. The Kentucky Geological Survey (KGS) estimates that the state's mineable coal reserves are 105 billion tons; 63 billion tons in the Eastern Kentucky Coalfield, and 42 billion tons in the Western Kentucky Coalfield.

Kentucky coal production reached a record high of 179 million tons in 1990, ranking the state second in the nation for coal production **(Fig. 10)**. This reflects a steady growth in the demand for electricity as well as increasing coal exports. Nearly 80% of the coal produced in the state is consumed by the nation's electric utility industry. Kentucky coal supplies 20% of the nation's coal energy demands **(Fig. 11)**.

Increasing restrictions on sulfur emissions from coal burning power plants as required under the federal Clean Air Act Amendments of 1990, may have an adverse impact on the future mining of coal reserves, especially in the Western Kentucky Coalfield, where the coal is higher in sulfur content **(Fig. 12)**. The Tennessee Valley Authority recently announced it will install scrubbers to allow the continued use of Western Kentucky coal in its power plants. In 1990, the agency purchased about 20% of the coal mined in the Western Kentucky coalfield.

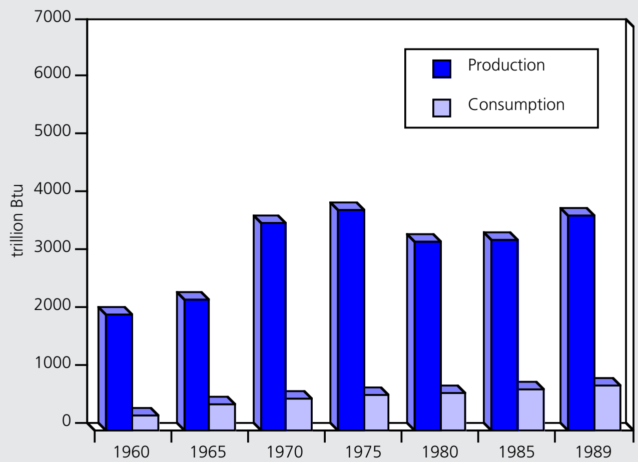
Figure 10
Annual Coal Production in Kentucky



Source: Kentucky Department of Mines and Minerals; Governor's Office for Coal and Energy Policy, 1991

Coal production reached an all time high in Kentucky during 1990. This production reflects the increasing demand for domestic electricity as well as expanding export markets.

Figure 11
Kentucky Coal Production/Consumption



Note: 1989 data most recent available.
Source: U.S. Department of Energy, EIA State Energy Data Report, 1991

Kentucky exports most of its coal to markets outside the state. State coal production supplies 20% of the nation's coal energy demands.

Increasing restrictions on air emissions from coal-burning power plants may have an impact on the future use of Kentucky coal. This is especially the case in Western Kentucky where coal is high in sulfur content.

Figure 12
Percent of Kentucky Coal Meeting Selected Emission Standards

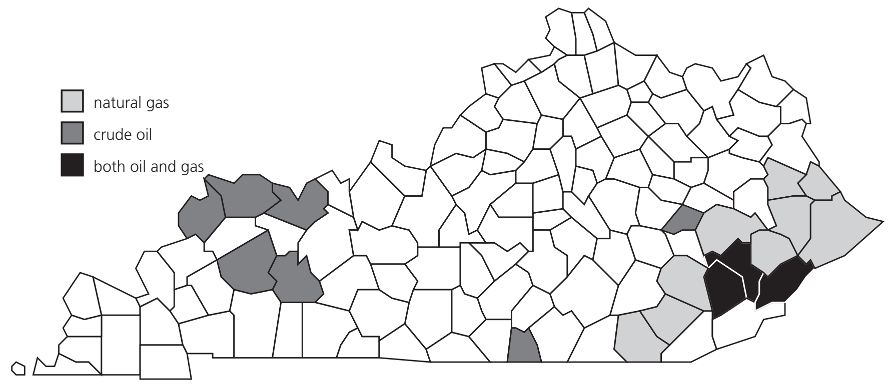
Selected Potential Emissions Standards (lbs. SO_2 per 10^6 Btu)	**Percent Coal Meeting Compliance Standards** Eastern Kentucky	Western Kentucky
1.2	43	<2.5
1.1	25	<1.0
1.0	20	<1.0
0.9	7	<1.0
0.8	5	<1.0
0.7	3	<1.0
0.6	<1	<1.0

Source: Kentucky Geological Survey, 1990

According to the Kentucky Geological Survey, maintaining high levels of coal production in the future may also be increasingly difficult because of the availability of coal resources. Approximately 29.9 billion tons of coal have been classified as recoverable in the state and an estimated 11.7 billion tons have been mined.

Kentucky oil production occurs in 43 counties but only ten account for 70% of the oil produced. Natural gas is produced in 33 counties. Twelve counties, however, supply 92% of the natural gas produced in the state.

Figure 13
Leading Oil and Gas Producing Counties in Kentucky



Source: Kentucky Department of Revenue, 1991

Production of Petroleum in Kentucky Decreasing; Supplies Little of State's Demand

Kentucky has an estimated 25 million barrels of proven petroleum reserves, less than 1% of the nation's 27 billion barrels of oil reserves. Crude oil has been produced in the state since 1819. Since then, oil wells have been drilled in more than half of the state's 120 counties. Production currently occurs in 43 counties, but ten—Henderson, Union, Lee, Muhlenberg, Daviess, Hopkins, Clinton, Perry, Letcher, and Leslie—account for 70% of all oil produced in the state **(Fig. 13)**. Most of the Kentucky's 20,000 active wells are "stripper" wells which produce less than ten barrels of oil per day.

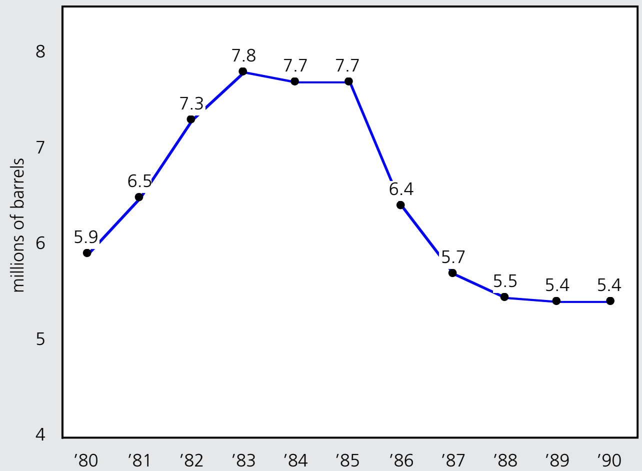
Petroleum production peaked in the state during 1959 at 27 million barrels, and has steadily declined since then. While state oil production increased somewhat in the 1980s, it declined again in 1985 when world oil prices dropped as low as $10 a barrel. Recent events in the Middle East have renewed interest in domestic oil production. For example, the number of permits to drill oil in Kentucky increased during 1990, but overall oil production continues to decline in the state. Production in 1990 was 5.4 million barrels, the lowest recorded since 1980 **(Figs. 14 and 15)**. Kentucky is ranked twenty-first out of the 31 states with significant oil production.

Crude oil production in the state supplies little of Kentucky's petroleum product demands. Most of the petroleum used here is produced in other states, or is imported from foreign countries. About 35 major petroleum companies serve Kentucky from refineries throughout the Eastern U.S.

It is difficult to determine whether oil production will increase in Kentucky as the U.S. seeks to reduce dependence on foreign oil. Foreign imports were reduced from 46% to 42% between 1977 and 1990. This reflects a decrease in oil imported from Middle East OPEC countries, from a high in 1977 of 8.6 million barrels a day, to 7.2 million barrels a day in 1990. Concurrently, the import of crude oil from the non–OPEC nations of Mexico, England, and Canada has grown.

The proposed National Energy Strategy, released in 1991, seeks to increase domestic oil production by opening up protected areas such as the National Arctic Preserve and other ecologically-sensitive regions for drilling. Legislation to allow this drilling is under consideration in the U.S. Congress where it failed to win the support of the Senate, but is expected to be passed by the House. The Bush Administration is reported to be a strong advocate of drilling in these areas. The national strategy has been heavily criticized for promoting these activities rather than focusing on conservation options that would save more oil than drilling in the sensitive areas would yield.

Figure 14
Crude Oil Production in Kentucky

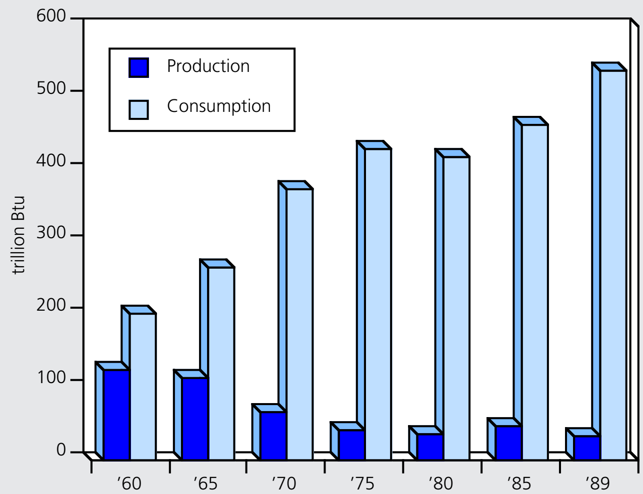


Source: U. S. Department of Energy, EIA State Energy Data Report, 1991

Petroleum production peaked in the state in 1959 but has since declined. Kentucky is ranked twenty-first out of 31 states with significant oil production. Most of Kentucky's 20,000 oil wells are stripper wells that produce less than ten barrels of oil a day.

State oil production supplies little of Kentucky's needs. Most oil produced in Kentucky is shipped out–of–state via pipelines.

Figure 15
Kentucky Crude Oil Production/Consumption



Note: 1989 data most recent available.
Source: U.S. Department of Energy, EIA State Energy Data Report, 1991

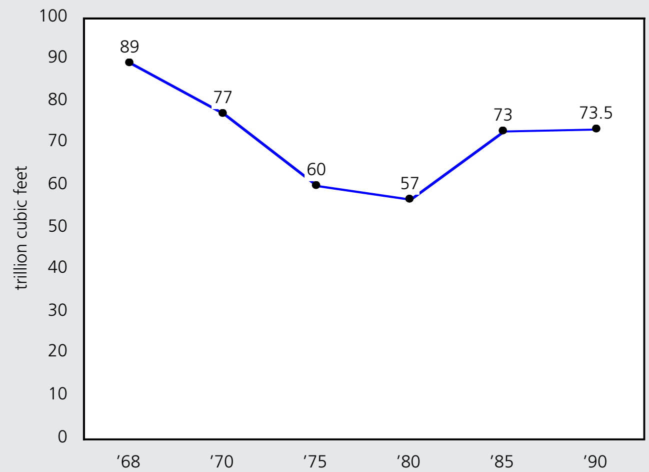
Natural Gas Production in Kentucky Increasing; Most Gas Transported to Other States

Proven natural gas reserves in Kentucky are estimated to be nearly 940 billion cubic feet. Natural gas production occurs in 33 counties. However, 12 counties account for 92% of the natural gas produced in the state. They are, in order of production: Pike, Floyd, Knott, Martin, Perry, Leslie, Whitley, Letcher, Clay, Knox, Johnson, and Breathitt. There are approximately 10,000 active gas wells operating in the state.

Natural gas production in Kentucky declined dramatically during the 1970s, but has increased through the 1980s, remaining steady at about 73 trillion cubic feet **(Figs. 16 and 17)**. Although Kentucky produced enough natural gas to meet almost 40% of the state's demand, about 90% of natural gas consumed here came from other states. Gas is transported by a number of gas pipelines operated by six major companies. There are 41 natural gas systems, including municipals and those which are privately owned, currently operating in the state. Gas is transported through the state by 61 pumping stations and many smaller pipeline systems. Natural gas produced in Kentucky, in turn, is transported via pipeline for consumption elsewhere.

In addition to coal, gas, and petroleum reserves, Kentucky has 4 billion barrels of oil reserves in tar sands, representing about 6% of the U.S. total. There is also an estimated 12.3 to 170 billion barrels of oil potential in black shale rocks within the state. These estimates indicate that the state has from 1% to 14% of the nation's oil shale reserves. The Kentucky Institute of Mines and Mineral Research indicates that there are about 28.9 billion tons of oil shale reserves in 15 counties. These resources have not been tapped as an energy source due to economic and technological difficulties.

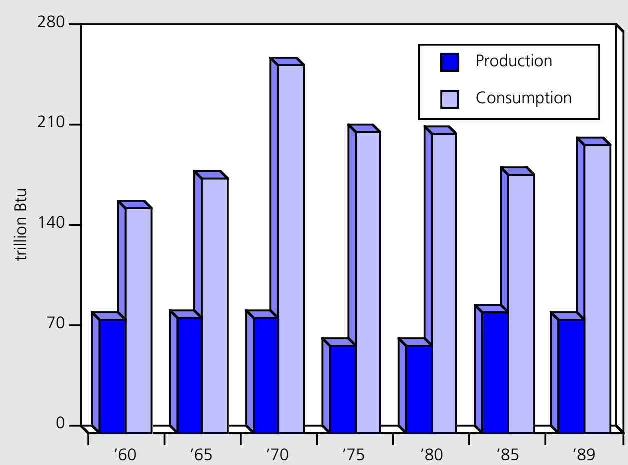
Figure 16
Natural Gas Production in Kentucky



Source: U. S. Department of Energy, EIA State Energy Data Report, 1991

Natural gas production in Kentucky declined during the 1970s but has since increased. Over 10,000 wells produced 73.5 trillion cubic feet of natural gas in 1990.

Figure 17
Kentucky Natural Gas Production/Consumption



Note: 1989 data most recent available.
Source: U. S. Department of Energy, EIA State Energy Data Report

Kentucky produces about 40% of the natural gas needed to meet state demands. However, 90% of the gas consumed in the state during 1989 was imported from the south through pipelines.

Renewable Fuels

Renewable resources such as wood, hydroelectric, wind, and solar power contribute 4% of U.S. energy demands. Events in the Middle East have revived interest in renewable fuels as a supplement to meet the nation's energy needs. With aggressive research and development, renewable resources could supply 28% of the nation's energy needs by the year 2030, according to the U.S. Assistant Secretary of Energy.

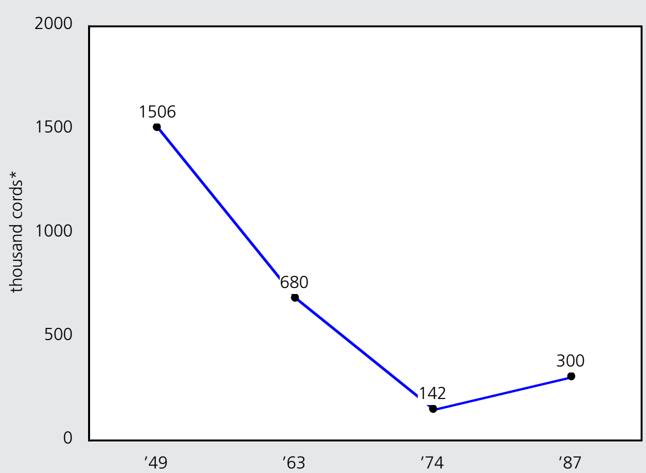
Cutting Wood for Fuel Increasing in Kentucky; 35 Industries Use Wood for Fuel

Kentucky possesses great quantities of renewable fuels. Forests in the state represent an estimated renewable energy reserve of 136 trillion Btu. Cutting wood for energy peaked during the late 1940s when wood was used in industrial boilers and for home heating **(Fig. 18)**. The increased availability of electricity, coal, and petroleum resulted in the decreasing use of wood as an energy source. During 1973, the removal of trees from Kentucky forests for fuel began increasing again due to the oil embargo and higher fuel prices. Approximately 300,000 cords of wood were harvested for fuel in 1987, the highest level since 1974.

About 35 Kentucky industries currently use wood as a fuel. The forest industry is making an effort to increase the role of wood products in both the state and U.S. energy markets. Recent advances in efficient wood–burning equipment and the use of wood waste such as sawdust both as a fuel and supplement to coal, offer great potential for increasing the use of wood for fuel.

Figure 18

Annual Removal of Trees for Fuelwood in Kentucky



** A standard cord of firewood is equal to 80 cubic feet of wood or 3 logs 18" in diameter and 16' long.*

Note: 1987 data most recent available.

Source: U. S. Forest Service Surveys 1953, 1960, 1970, 1988

Kentucky once depended heavily upon wood resources for fuel. The increased availability of electricity, coal, and petroleum products resulted in the declining use of wood energy. Recent advances in wood burning technologies may increase the use of wood for fuel.

About 19% of Gasoline Consumed in Kentucky is Gasohol; Kentucky Ethanol Plants Not Operating Due to Economics, Demand

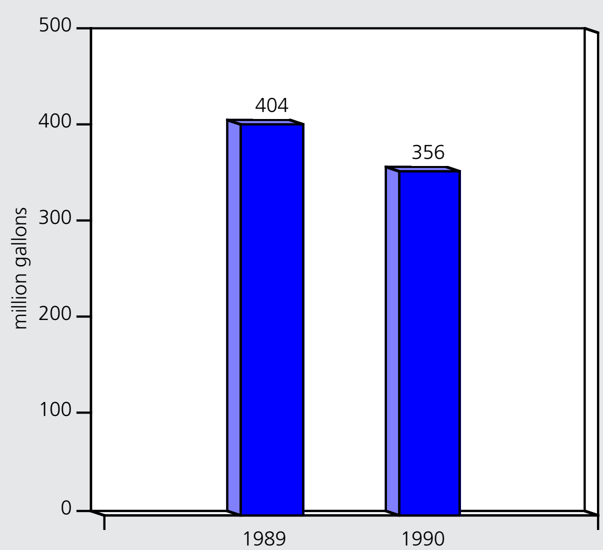
Agricultural products, particularly grain, can be used to produce renewable fuels known as ethanol. Ethanol is mixed with nine parts gasoline and sold as "gasohol," a motor vehicle fuel. It takes about one bushel of corn to make 2.5 gallons of ethanol. This extends gasoline while reducing carbon monoxide emissions from motor vehicles. National ethanol production increased significantly during the last decade from 20 million gallons in 1979, to 825 million gallons in 1989.

Several Kentucky gasoline suppliers sell ethanol fuel blends. In 1990, 19% of the gasoline consumed in the state was gasohol. This was a slight decrease from 1989 when gasohol accounted for 21.5% of all the gasoline used **(Fig. 19)**. In comparison, the amount of gas containing ethanol consumed nationally was about 6% in 1990.

A $66 million ethanol plant, located in Franklin, Kentucky, produced 22 million gallons of ethanol fuel a year when it was operating in the mid–1980s. The facility used eight million bushels of corn and 62,000 tons of Western Kentucky coal annually to produce the fuel. The plant reopened, after its closure in the late 1980s, but recently closed again due to the loss of state tax credits and the relatively high cost of corn. Another facility, AKE of Louisville, plans to produce ethanol but has not started production for essentially the same reasons.

The market for ethanol fuel is expected to improve and could provide increased economic opportunities to Kentucky's agricultural and coal industry. To encourage the use of ethanol in Kentucky, state legislation proposed in 1990 would have required all gasoline sold in the state to include ethanol. This measure, however, failed to pass.

Figure 19
Consumption of Gasohol* in Kentucky



**ethanol and gasoline blended fuels*
Source: Federal Highway Administration, Monthly Gasoline Reports, 1989–1990

In 1990, 19% of the gasoline consumed in Kentucky was gasohol. This was a slight decrease from 1989 when gasohol supplied 21.5% of all the gasoline used in the state. In comparison, 6% of the gasoline consumed nationwide in 1990 was gasohol.

Hydropower Plants Produce 6% of Electricity Consumed in Kentucky; Use of Active Solar Energy Limited in State

About 10% of the nation's electricity is generated by hydroelectric plants. Kentucky has seven hydroelectric plants located on six waterways. In 1989, these facilities produced 45 trillion Btu of electric power, about 6% of the electricity consumed in the state. Energy produced by these facilities has fluctuated over the years due to stream flow conditions. Hydroelectric production rates in 1989, however, were at their highest level since 1965. A private $160 million hydropower project proposed for the Ohio River in Western Kentucky is scheduled to begin construction in 1994.

Solar power, another renewable energy source, can be converted to electricity or used directly for heat. Solar collection and heating systems are used throughout the state, but it is not known how much of this energy is produced or consumed. The state authorized $4.3 million in tax credits for the residential and commercial purchase of solar equipment in 1984, $7.7 million in 1985, and $882,000 in 1986, but has since eliminated this program.

National data show that the use of solar energy steadily increased during the 1970s. During the last ten years, interest in solar energy has waned due to falling oil prices and the loss of federal tax credits in 1985. The federal solar energy budget went from a high of $600 million during the Carter Administration to a low of $70 million in the Reagan Administration. Interest is again increasing in solar energy due to higher fuel costs. The federal budget allotted $100 million in 1991 to solar energy and has increased that amount to $146 million in 1992.

The Kentucky Division of Energy (KDE) is actively promoting the use of solar energy by educating homebuilders and the public about passive solar gains which do not require expensive investments to achieve. Producing cost–effective solar energy from active solar devices such as panels is more limited in Kentucky than in some parts of the country due to the state's topography and cloud conditions. Widespread use of active solar technologies is not expected to grow significantly in the state.

Synthetic Fuels

Development of Synthetic Fuels Hindered by Economics and Production Capacity

Kentucky is promoting the development of synthetic fuel technologies, particularly coal liquefaction. Converting coal and other fossil fuels, such as oil shale and natural gas, to a liquid gas form has been explored since World War II. Interest in synfuels research increased in the 1970s due to the oil supply crisis and high gasoline prices, but suffered federal budget cuts in the 1980s. There are few plants devoted to liquefying coal for fuel in the United States. Six pilot synfuel plants in Kentucky were cancelled after federal funds were not forthcoming.

Economics and limited capacity to produce synfuels have affected the commercial use of this energy resource. It costs about $33 to produce a barrel of synfuel compared to $22 per barrel for imported oil.

Energy Efficiency and Conservation

Wasted Energy Could Provide 25% of Kentucky's Demands; Efficiency and Conservation Practiced in Some Schools and Hospitals Results in 27–34% Savings

An often overlooked source of energy is energy that is currently wasted. KDE estimates that 25% of all energy used is wasted due to inefficiency and overconsumption. Wasted energy can realistically be conserved and used to supply energy needs, if measures are employed to recapture and use this existing resource. Major electric utilities and industries in Kentucky are focusing efforts to improve efficiency. Old equipment is being replaced with more efficient furnaces and other process equipment throughout this sector.

Individual efforts to improve energy use are also common. These include carpooling, winterizing homes, turning down thermostats, and purchasing cars with better gas mileage. Much more, however, could be done to achieve energy efficiency and conservation in offices, industries, schools, businesses, and homes throughout the state.

KDE has been assisting schools and hospitals conduct energy audits and retrofits since 1978. During 1990, the program resulted in savings of 27% in 69 schools after they installed energy saving systems such as new boilers, energy management systems, insulation, and employed other conservation practices. Similar systems used in 25 hospital buildings reduced energy usage 34%. The Louisville Resource Conservation Council was established in 1990 to promote energy conservation in nonprofit community service agencies in the metropolitan area. The program provides agencies a wide range of technical and financial services to make their facilities more energy efficient. Several facilities participating in the program have realized significant energy cost savings. Unfortunately, state budget cutbacks in 1993 and 1994 will significantly curtail this and other state energy programs.

Experts estimate that businesses, industries, and other facilities could decrease their energy use by an average of 25% by installing appropriate systems and employing conservation practices. Fuel costs, however, usually drive efforts to conserve energy. Because the U.S. has lower energy rates than any other industrialized country, energy conservation and efficiency have not been quickly adopted as an energy resource in Kentucky and the nation.

State agencies should serve as models for energy conservation and efficiency. The legislature recently mandated that the Natural Resources and Environmental Protection Cabinet evaluate an energy conservation program for state buildings. Current state government energy costs are estimated at $40 million annually. The Kentucky Division of Energy has indicated that state government could save at least $10 million a year if energy conservation and efficiency measures are implemented.

Energy Costs

State Energy Costs Increase Dramatically Between 1970–1988; Electric Rates Still Below National Average

The state is using more energy than ever before, and is paying more for it. Between 1970 and 1988, coal, natural gas, and petroleum prices rose from 300% to 500%. Kentucky's average 1988 energy price of $7.26 per million Btu, however, ranked near the national average of $7.28 per million Btu. Total annual energy expenditures per person in the state during 1988, combining industrial, residential, and other uses, were estimated at $1,719. This was about 4% above the national average of $1,652 which was primarily due to intensive energy use by some of the state's industries.

The price of energy varies depending on the source **(Fig. 20)**. During 1990, coal continued to have the overall lowest rate in Kentucky at $1.26 per million Btu. The cost of coal is below the national average of $1.50 per million Btu. Natural gas prices in the state during 1990 were $3.89 per million Btu. Petroleum ranked the highest at $6.46 per million Btu. The direct costs of these three energy sources increased until 1985, but have since declined by about 12%.

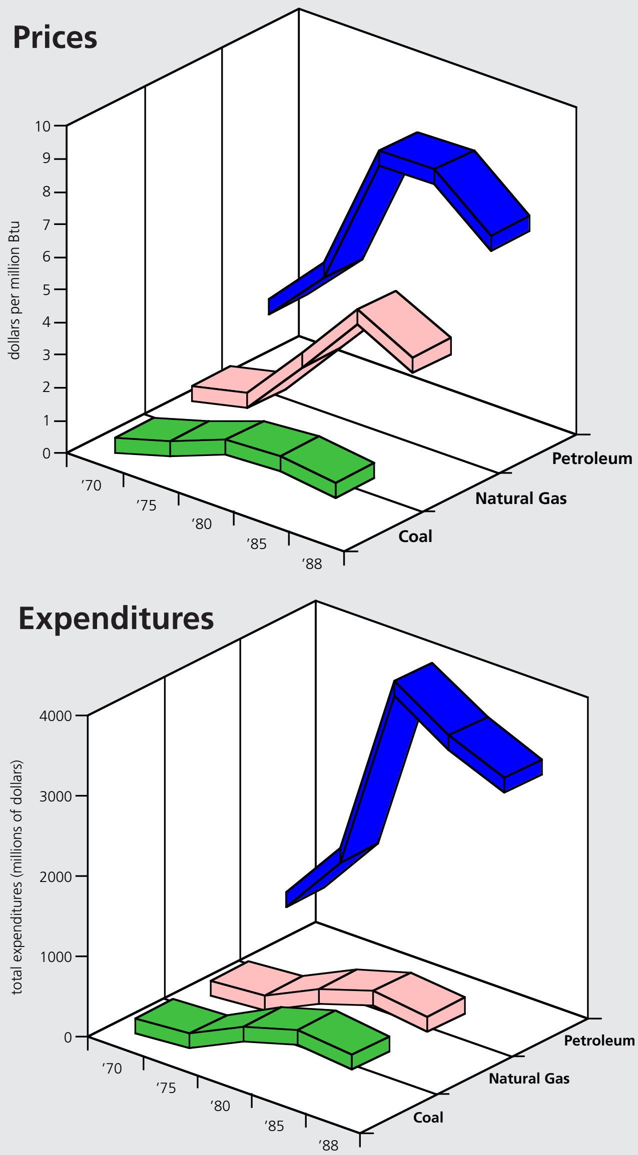
Total energy expenditures in 1988 for Kentucky homes, businesses, and industries were $3.1 billion for petroleum products, $1 billion for coal, and $637 million for natural gas. The greatest expenditures occurred in the transportation sector (37%) followed by industrial (30%), residential (21%), and commercial (12%) **(Fig. 21)**.

Energy rates not only reflect inflation, but also include the costs to recover coal, oil, gas, and other resources and convert them to energy. Additional costs are borne to control environmental impacts caused by mining and burning these fuels. Pollution control equipment, such as scrubbers on 17 of the state's 58 coal–fired units, has reduced air emissions of sulfur dioxide in Kentucky. Additional controls and further air emission reductions, particularly for the state's coal power plants, will be required as the federal Clean Air Act Amendments of 1990 take effect.

The state estimates electric rates could increase an average of 12% due to the emission reductions and environmental controls mandated by the act. Kentucky, however, has some of the lowest electric rates in the nation due to its coal supplies. The average state electric rate per million Btu in 1990 was $15.08, compared to the national average of $18.68.

Figure 20

Energy Prices and Expenditures in Kentucky

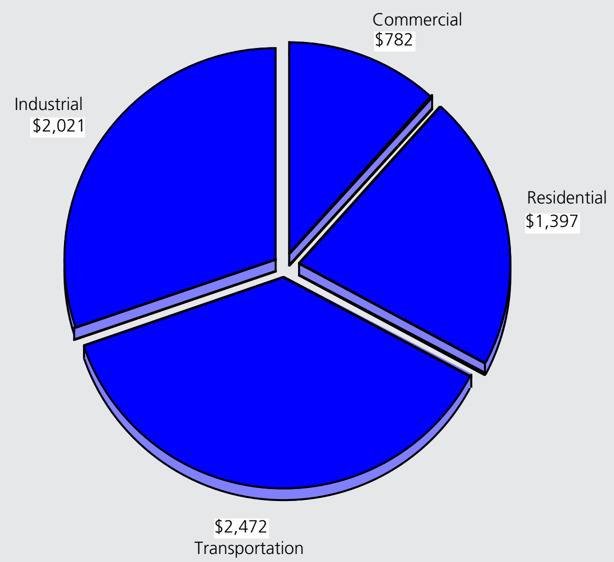


Note: 1988 data most recent available.

Source: State Energy Price and Expenditure Report, 1988; U.S. Department of Energy, EIA State Energy Data Report, 1991

Between 1970 and 1988, coal, natural gas, and petroleum prices rose from 300% to 500%. Kentucky's average cost of energy per million Btu ranks near the national average.

Figure 21
Kentucky Energy Expenditures by Sector
(millions of dollars)



Note: 1988 data most recent available.
Source: State Energy Price and Expenditure Report, 1988; U.S. Department of Energy, EIA State Energy Data Report, 1991

Kentucky homes, businesses, and industries spent $3.1 billion for petroleum products, $1 billion for coal energy, and $637 million for natural gas during 1988. The greatest expenditures occurred in the transportation sector, followed by industry, and residential use.

Energy Strategies

Kentucky's Draft Energy Strategy Focuses on Coal; Energy Shortage Contingency Plans Under Development

The Governor's Office for Coal and Energy Policy is in the process of developing "Kentucky's Coal and Energy Plan." In the draft plan, the state's energy goal is, "to obtain the fullest economic potential from the state's energy resources and to ensure that the Commonwealth has abundant and economical energy for its development and financial well being."

The plan primarily addresses the impacts of the national Clean Air Act Amendments of 1990 on the coal industry and the state's economy. Some recommendations of the plan include the following:

- Assistance to electric industries to encourage the continued use of Kentucky coal;
- Further development of coal market opportunities overseas;
- Encourage coal companies to develop economic opportunities in their communities;
- Support and development of clean coal technologies to reduce emissions and greenhouse gases instead of taking actions such as carbon taxes or mandated cuts in carbon dioxide emissions; and
- Support additional research on carbon dioxide emissions and global warming.

The draft "Kentucky Coal and Energy Plan" also considers the state's other energy resources including natural gas, solar, solid waste, and conservation. Recommendations include the need to:

- Assess and identify natural gas and petroleum market opportunities and transportation systems;
- Assess the reliability of electric supplies as regulatory pressures increase;
- Promote feasible types of solar energy;
- Develop energy production uses for wood waste;
- Promote the use of municipal waste for energy; and
- Promote measures to encourage efficient energy use.

The Governor's Office for Coal and Energy Policy is unsure when the draft energy plan will be finalized. To meet some of the goals outlined in the draft plan, the Kentucky Division of Energy is developing strategies to promote energy conservation programs and alternative energy technologies. The Division is also working to create centralized access to energy information and is preparing contingency plans for potential energy shortages.

State Critical of National Energy Strategy; Recommends Emphasis Should be on Coal

The draft "Kentucky Coal and Energy Plan" is also critical of the Bush Administration's proposed National Energy Strategy (NES). It charges that the national strategy fails as an energy policy by not setting a goal of reducing U.S. dependence on imported petroleum.

Under the NES, the nation will be importing 50% of its petroleum in the year 2010. The state energy plan suggests that the U.S. reduce its dependence on foreign oil from 50% to 40% within ten years, and by 1% each year after until imports no longer constitute a threat to national security or supply. It recommends that emphasis be placed on the development of coal which represents 80% of the nation's non–renewable energy resources.

The NES has also been criticized by many for its lack of focus on energy conservation, its emphasis on domestic oil production in environmentally sensitive areas, and its promotion of nuclear energy.◆

Appendix A
Kentucky's Environmental Indicators

The U.S. Environmental Protection Agency has recommended that states establish a list of "environmental indicators" by which to measure the effectiveness of environmental regulatory programs and trends in environmental quality. Environmental indicators can also be used to guide resource allocation for programs, priority setting, strategic planning, and to generally support the decision making process.

The most preferred indicators according to the U.S. EPA are those which:

- Measure the health or ecological effects of pollutants.
- Demonstrate a direct link between program activities and improvements in achieving the program's ultimate goal.
- Are based on data that are collectible and of sufficient quality to be an accurate measure of trends in environmental health.
- Account for external factors that could result in unfair evaluations.

The Kentucky Department for Environmental Protection has identified a number of environmental indicators that can be used to measure the effectiveness of the agency's programs. The Department's list of indicators include the following:

Kentucky Environmental Indicators

Indicators	Measurements
National Ambient Air Quality Standards Attainment	
Measures of areas in attainment for NO_2, SO_2, lead, CO, ozone, & PM_{10}	Percent population living in nonattainment area by pollutant. Number of people and number of days exposed to high levels of pollutants in non-attainment areas.
Emissions of SO_2, VOCs, lead, NO_x, CO & PM_{10}	Actual emissions (tons/year) from stationary sources and potential emissions from mobile and area sources. Emissions by source (power plants, mobile, manufacturing, area).
Ambient air quality for NO_2, SO_2, lead, CO, ozone, & PM_{10}	Maximum ambient air quality by air control region and pollutant. Number of exceedences of ambient standards.
Air Toxics	
Emissions of air toxics from stationary sources	Tons per year (total). Tons of known or suspected carcinogens emitted per year in air control regions.
Pollution prevention	Tons of potential emissions eliminated by early reduction program
Facilities in compliance with MACT*	Percent of facilities in compliance with new MACT* standards.
Acid (Rain) Deposition	
Emission rates of acid rain precursors (SO_2 & NO_x)	Tons of SO_2 and NO_x emitted. Percent SO_2 to 1980 baseline. Percent of facilities required by the Clean Air Act Amendments of 1990 in compliance to reduce acid deposition precursors.

Acid (Rain) Deposition (continued)

pH of precipitation	Average pH at ambient monitoring stations.

Surface Water Quality

Designated use support	Percent of river miles supporting designated use.
Water quality	Metals, organics, total organic compounds, total suspended solids, temperature, pH, fecal coliform, and biotic indices.
Toxics in streams	Toxic chemicals released to surface waters.
Water discharge loadings at permitted facilities	Total annual nutrients, metals, and conventional loading from KPDES sources. Number of permits (major and minor). Number of package treatment plants. Number of wastewater treatment facilities in compliance. Number of facilities in significant noncompliance with KPDES permit requirements.
Trophic status of lakes	Percent of lakes classifies as eutrophic, mesotrophic, and oligotrophic.
Loadings from nonpoint sources	Total suspended solids, nutrient and pesticide levels at selected monitoring sites.
Sediment contamination	Metals and organics concentration in stream sediment.
Pollution prevention	Number of publicly-owned wastewater treatment facilities implementing pollution prevention programs.
Fish tissue	Bioaccumulative toxic compounds.
Fishing advisories	Number of miles of streams with consumption advisories.
Swimming advisories	Number of miles of streams with advisories or bans.
Spills	Number of reported spills.

Wetlands

Wetland acreage lost/gained	Total acres of wetland. Total acres of wetland disturbed. Acres of wetlands restored, mitigated. Functional quality of remaining wetlands.

Groundwater

Groundwater quality	Percent of selected monitoring wells exceeding drinking water standards.

Groundwater (continued)	
Sources of groundwater contamination	Number of water supply wells closed due to contamination. Number of solid waste landfills with groundwater contamination. Number of hazardous waste sites with groundwater contamination. Number of leaking underground storage tanks. Percent of population utilizing septic tanks. Number of leaking wastewater lagoons. Number of oil and gas pits.
Water Resources	
Water withdrawals	Water withdrawal by major river basin in million gallons per year. Water withdrawal per capita by major river basin. Water withdrawal by source (public water supply, industrial, irrigation, electric generation, domestic). Percent of low-flow streams permitted for withdrawal by river basin.
Floodplain projection	Annual flood damage (dollars and personal injury). Number of communities participating in and enforcing Community Flood Abatement Program.
Dams	Dam failures.
Drinking Water	
Significant noncompliance of community water systems	Number of community water systems. Number of people utilizing facilities in significant noncompliance of drinking water regulations.
Long-term water supply	Number of drinking water supplies dependent on surface water with high risk of shortage in the event of a 20-year drought. Number of water supply systems dependent on groundwater vulnerable to contamination. Number of public systems with tap-on bans. Number of community water supply systems with well-head protection programs.
Private wells	Population at risk from consumption of untreated groundwater. Percent private wells tested showing contamination.
Solid Waste Management	
Generation	Tons of solid waste generated annually. Tons per capita generated.
Collection	Percent of population using waste collection systems. Number of counties with universal garbage collection. Number of counties with citizen advisory groups.

Solid Waste Management (continued)	
Waste reduction	Tons of materials recycled by type (paper, glass, oil, plastic, aluminum). Tons of materials eliminated from landfills (compost, waste-to-energy). Pounds per capita recycled. Number of abandoned vehicles collected. Tons of solid waste recovered from state agencies. Dollars spent by state purchasing recycled products.
Disposal	Percent of landfills cited for major violations. Remaining capacity at permitted sites. Tons of solid waste landfilled. Percent of sludge disposed by landfarming. Percent of landfills with groundwater contamination. Number of open dumps. Number of counties with contracts for disposal of solid waste.
Hazardous Waste Management	
Generation	Tons of hazardous waste generated by type. Number of hazardous waste generators.
Reduction	Percent of generators implementing waste reduction programs.
Treatment and disposal	Tons of hazardous waste treated or disposed off-site or on-site. Tons of hazardous waste disposed in landfills both on and off-site. Number of corrective action sites. Number of facilities in significant noncompliance. Capacity of hazardous waste facilities (tons/year) by type of process (landfill, incinerator, solvent recovery, etc.) Number of illegal non-notifiers. Tons of hazardous waste treated and disposed by type of process (incineration, recycling, treatment, disposal). Number of sites with groundwater contamination.
Hazardous Waste Sites	
Cleanup of hazardous waste sites	Number of sites identified (NPL**, state inventory). Number of sites characterized. Number of sites where remediation completed and operations and maintenance initiated. Number of groundwater remediation starts. Number of remediation starts.
Underground Storage Tanks	
Tank status	Percent of tanks upgraded or closed. Number of non-notifiers identified. Percent of tanks meeting release detection requirements.
Cleanup	Number of tanks closed. Number of facilities cleaned up and closures approved.
Miscellaneous	

Manufacturing	Percent change in number of industrial sources (SIC Code 20-39). Value added (dollars).
Demographics	Percent population growth.
Travel	State highway vehicles miles traveled.
Energy use	Number of kilowatts produced annually.
Agriculture	Tons of pesticides used annually. Tons of fertilizers used annually.

* *MACT - Maximum available control technology*

** *NPL - National Priority List of Superfund sites*

Source: Kentucky Department for Environmental Protection, 1991

Appendix B
Abbreviations

ADD	Area Development District
AG	Kentucky Attorney General
AVS	Applicator Violator System
BIRP	Kentucky Beverage Industry Recycling Program
BTU	British Thermal Unit
CFC	Chlorofluorocarbons
CO	Carbon monoxide
COE	U.S. Army Corps of Engineers
COs	Cessation Orders
DAML	Kentucky Division of Abandoned Mine Lands
DAQ	Kentucky Division for Air Quality
DBNF	Daniel Boone National Forest
DDT	Dichloro–Diphsdyl–Trichloromethane (first chlorinated hydrocarbon insecticide)
DEP	Kentucky Department for Environmental Protection
DES	Kentucky Disaster and Emergency Services
DHS	Kentucky Department of Health Services
DMM	Kentucky Department of Mines and Minerals
DOW	Kentucky Division of Water
DOE	United States Department of Energy
DSMRE	Kentucky Department of Surface Mining Reclamation and Enforcement
DWM	Kentucky Division of Waste Management
EDC	Ethylene dichloride
EIA	Energy Information Agency
EPA	United States Environmental Protection Agency
EQC	Kentucky Environmental Quality Commission
ETS	Environmental tobacco smoke
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
KDE	Kentucky Division of Energy
KDF	Kentucky Division of Forestry
KDFWR	Kentucky Department of Fish and Wildlife Resources
KGS	Kentucky Geological Survey
KHA	Kentucky Hospital Association
KPDES	Kentucky Pollutant Discharge Elimination System
KRC	Kentucky Resources Council
LEECO	Louisville Energy and Environment Corporation
LPG	Liquid Propane Gas
MACT	Maximum Available Control Technology
MCL	Maximum Contaminant Level
MRF	Materials recovery facility
MSD	Louisville/Jefferson County Metropolitan Sewer District
NAAQS	National Ambient Air Quality Standards
NES	National Energy Strategy
NGA	National Governor's Association
NOx	Nitrogen oxide
NO2	Nitrogen dioxide
NPC	Kentucky Nature Preserves Commission
NPL	National Priority List (Superfund)
NPS	Non Point Source Pollution
NREPC	Kentucky Natural Resources and Environmental Protection Cabinet
NSWMA	National Solid Waste Management Association
NWI	National Wetland Inventory

OPA	Oil Pollution Act
OPEC	Organization of Petroleum Exporting Countries
ORSANCO	Ohio River Valley Water Sanitation Commission
ORWs	Outstanding Resource Waters
OSHA	National Occupational Health and Safety Administration
OSM	Office of Surface Mining
PCB	Polychlorinated biphenyl (group of toxic, persistent chemicals used in transformers)
pCi/L	Picocuries per litre
PGDP	Paducah Gaseous Diffusion Plant
PM10	Particulate matter (nominally 10 microns and less)
PPM	Parts per million
POTW	Publicly–owned treatment works
RAMP	Rural Abandoned Mine Land Program
RCRA	Resource Conservation and Recovery Act
RDF	Refuse derived fuel
SARA	Superfund Amendments and Reauthorization Act
SCS	U.S. Conservation Service
SMCRA	Surface Mining Control and Reclamation Act
SMIS	Surface Mining Information System
SO_2	Sulfur dioxide
STEP	States Evaluation of Progress
STP	Sewage Treatment Plant
SWMU	Solid waste management unit
THM	Trihalomethane
TSD	Hazardous waste treatment, storage, and disposal facilities
TSP	Total suspended particulates
TVA	Tennessee Valley Authority
ug/m^3	Micrograms per cubic meter
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
VET	Vehicle Emission Testing
VOC	Volatile organic chemicals
WWTP	Wastewater Treatment Plant
ZID	Zone of initial dilution

County Reference Map

Appendix C

Source: University of Kentucky, Department of Geography, 1992

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Page 21 Second paragraph, fourth sentence should read " The Legislature cut this emission fee to raise approximately $2 million to $2.5 million a year and provided general funds to cover the remainder of the Division's expenses."

Page 25 Figure 7 - Clean water in first set of bars should read "Clean Water Act."

Page 34 Figure 5 - (1) The units on the "Inspections" chart should read "number of inspections", (2) the units on the "Agreed Orders" chart should read "number of agreed orders", (3) the "Violations" chart should be titled "Notices of Violations" with units reading "number of notices," (4) the "Fines Collection" chart should be titled "Penalties Collected" with eh units reading "penalties collected".

Page 35 Second paragraph, second sentence should read "Since 1974, $556 million..."

Page 37 The first sentence in text under Figure 8 should read "Since 1974, $556 million..."

Page 39 Second paragraph, first sentence should read "WWTPs were responsible for 28% of the fish kill incidents reported during 1990 and 1991.

Page 59 Figure 28 - The "Source" should read "Adapted from the U.S. Geological Survey, National Water Summary, Kentucky, 1984."

Page 62 Fifth paragraph, third sentence should read "contamination has been detected at 181 of the 254 potential <u>hazardous waste</u> sites investigated."

Page 65 Figure 32 - (1) Public supply bar chart should read "13% groundwater," (2) self-supplied bar chart should read "10% surface water." The "units on the chart should be "% of water withdrawn."

Page 77 Figure 45 - Add “Montgomery County, Mount Sterling W & S, 83% of population.”

Page 98 Third paragraph first sentence should read “SO_2 emissions from coal-fired utilities operating in KY decreased from 1.5 million tons in 1976 to 713,388 tons in 1990, a 48% decline.”

Page 132 Figure 12 - In the “Penalties” and “Active Cases” charts, 1989 should have three asterisks, which indicate earlier data was not available.

Page 133 Figure 13 - The top line of the chart depicts hazardous waste exports and the bottom line depicts imports.

Page 146 Under “Disposal” section - As of June 30, 1992, the updated status of municipal solid waste landfills in Kentucky was:

* 41 municipal landfills were permanently closed
* 5 were temporarily closed
* 27 existing landfills were to remain open until July 1995
* 12 new landfill permits were under review

Page 157 Figure 30 - (1) The single asterisk in the chart heading should note that the data is compiled by fiscal year (July 1 - June 30), (2) the double asterisk in “Notice of Violations” should note that a notice of violation may include several violations of environmental regulations, (3) there should be three asterisks which appear in “Penalties Collected” and “Cases” char for 1989 to indicate that earlier data was not available.